CHALLENGING PROBLEMS
IN
CHEMISTRY

(CLASSES XI-XII)

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FOREWORD

National Council of Educational Research and Training, New Delhi, has been continuously making efforts to improve the quality of school education by providing from time to time, guidelines to the teachers and students. The Council has taken yet another step to develop challenging problems in chemistry for senior secondary stages in order to arouse curiosity of the students to think, judge and find solutions of problems based on their understanding of the concepts. Thus to fulfil the said objective the Department of Education in Science and Mathematics (DESM) of NCERT, has undertaken a project entitled "Development of Challenging Problems in Chemistry for Senior Secondary Stages." Under this project, a material in photo-copied form containing more than 325 challenging problems in chemistry has been developed for the talented students of senior secondary stages (classes XI and XII). This material contains various types of problems such as thought provoking, structured and problem solving types. These problems are of higher abilities and are based on comprehension, application and skills.

The first attempt to develop sample challenging problems on a few units for class XI, was made by a team of chemistry faculty members of this Department namely: Dr. V.N.P. Srivastava, Prof. R.D. Shukla, Prof. (Mrs.) M. Chandra and Dr. (Mrs.) Kamlesh Mittal. Similarly, a few sample challenging problems for class XII were developed by Dr. V.N.P. Srivastava, Prof. R.D. Shukla and Prof. (Mrs.) M. Chandra. Further on the basis of these sample problems, challenging problems of nearly all

the units of classes XI and XII were developed in the two workshops consisting of subject experts and classroom teachers (as given in the lists at the end). After the development of the material it was tried-out in two phases (phase I for class XI and phase II for class XII) on talented students of two Kendriya Vidyalayas of Delhi. On the basis of the feedback received from the schools, the material was modified and edited. My special thanks are due to Dr. V.N.P. Srivastava for editing the material and coordinating this programme.

I am also thankful to all those involved in the development of this material and giving it a final shape.

Suggestions for the improvement of this material would be most welcome.

(R. D. Shukla)
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New Delhi.
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PREFACE

It has been observed that all the reforms related to the improvement of chemistry education at senior secondary stages are centred around the below average and average students only because their percentage population in a class is very high (i.e. nearly 75%). The above average students whose percentage in a class is very low (i.e. nearly 25%), feel neglected because we have mixed ability teaching in our schools, where below average, average and above average students are all taught together. Thus the whole teaching learning process i.e. syllabus, textbook, test items, teaching methods, assessment procedures etc. are mostly focussed around the average students only. In these materials, very little scope has been provided for above average students. Further, in the school examinations and public examinations at senior secondary stage, the questions are asked on a set pattern, mostly based on knowledge and comprehension level only, which cater to the needs of the average students only. A very few questions of higher abilities are reflected in these examinations. Therefore, bright students can score well in these examinations but their talents are not nurtured.

For the nurturance of the talents of above average students, various problems such as thought provoking, structured and problem solving types in chemistry have been developed in the present material. Thus, the main objective of this material is to provide varieties of unusal challenging problems on various aspects of chemistry of classes XI and XII. Also solution of some difficult problems have been given in the form of hints. These problems are of higher abilities and are based on

comprehension, application and skills. It is hoped that this material would further nurture the talents of the talented students.

Suggestions for the improvement of this material would be most welcome

(V.N.P. Srivastava)
Reader in Chemistry
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Questions
on
Physical Chemistry
(Class - XI)

Q1. The atmospheric pressure is measured by using a barometer shown in Fig.1. The pressure is measured in terms of height of the mercury in the barometer tube, from it's level in the trough. The space above the mercury in the tube is empty and is called torricilium vacuum.

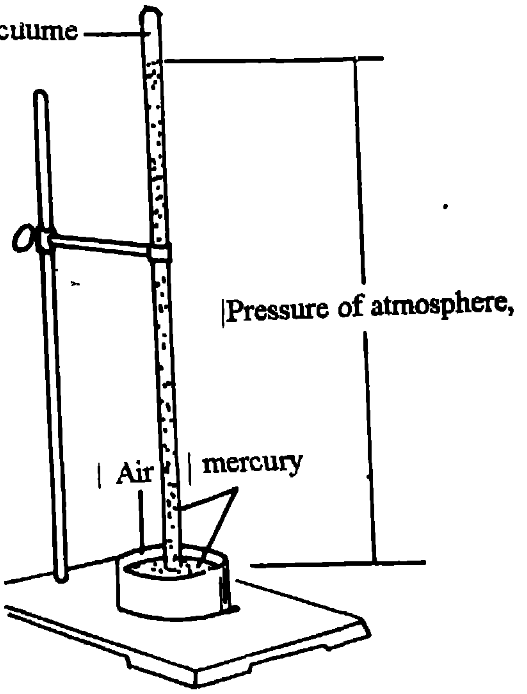


Fig. 1

(a) If water is filled in the barometer (density 1.00 g cm^{-3}) what would be its height when the pressure is exactly one atmosphere.

(b) Calculate the pressure of 1.00 atm in kg/m^2.

(c) A small amount of water is introduced in the barometer tube. It rises and reaches above the mercury level.

  (i) What will happen to the level of the mercury.

  (ii) The vapour pressure of the water is 2.06 kPa at the room temperature and some water still remains after the equilibrium is reached, calculate at what height would mercury stand if the pressure is exactly one atmosphere?

(d) Arrange the following pressures in their increasing order of magnitudes.

15 k Pa, 742 mm Hg, 0.89 atm and 650 torr.

Q2. The pressure exerted by a gas is measured with the help of a manometer shown in the figure 2. The pressure of the gas p_{gas} is obtained by the relation:

$$p_{gas} = p_{atm} + h$$

when it is more than the atmospheric pressure. And by the relation:

$$p_{gas} = p_{atm} - h$$

when it is less than the atmospheric pressure, p_{atm}. Here, h is the difference in the height of the mercury in the two limbs of the manometer.

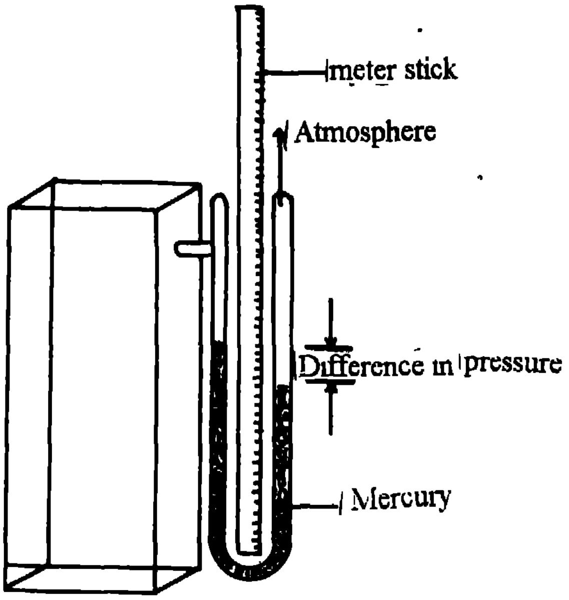


Fig. 2

In an experiment, the manometer was attached to a cylinder-piston arrangement and a certain quantity of a gas was filled in it, while keeping the temperature constant. The volume of the gas was changed by moving the piston and the manometer readings were recorded. The following data were obtained:

Atmospheric pressure = 74.0 cm Hg.

S.No.	Volume of the gas (litre)	Difference in the height of mercury in the monometer (h) (cm)	Level of mercury in the open limb of the manometer was higher/ lower than the other limb.
1.	5.0	56.24	lower
2.	2.5	38.48	lower
3.	2.0	29.60	lower
4.	1.6	18.50	lower
5.	1.4	10.53	lower
6.	1.0	14.80	higher
7.	0.7	52.86	higher
8.	0.5	103.6	higher
9.	0.4	148.0	higher
10.	0.2	370.0	higher

(a) Calculate the pressure of the gas p_{gas} and complete the following table.

S.No.	Volume of the gas (litre)	Pressure exerted by the gas (P_{gas}/cm Hg.)
1.	5.0	
2.	2.5	
3.	2.0	
4.	1.6	
5.	1.4	
6.	1.0	
7.	0.7	
8.	0.5	
9.	0.4	
10.	0.2	

(b) What are the conditions of the experiment?
(mention fixed parameters)

(c) State the qualitative relationship between the pressure and the volume of the gas.

(d) Plot a graph between pressure and volume of the gas and determine its volume when the pressure is 100 cm Hg.

(e) The relation between the pressure and volume of a gas under the conditions of the experiment can be expressed as:

$$P = kV$$

Determine slope x graphically and rewrite the above relation. (Hint: Take logarithm of the above relation and plot log P versus log V)

(f) Determine k from the graph obtained in (e) and verify the value numerically from the table constructed in (a).

(g) Now state the quantitative relationship between the pressure and the volume of the gas in your words along with the conditions under which it is valid.

(h) Name the gas law which you have found.

Q 3. Behaviour of gases were studied in a detailed way by many renowned scientists. The results of these workers are expressed in the form of different gas laws:

(i) $P \propto \frac{1}{V}$ or $PV = $ constant (Boyle's law)

(ii) $V \propto T$ or $\frac{V}{T} = $ constant (Charle's law)

(iii) $P \propto T$ or $\frac{P}{T} = $ constant (Gay-Lussac's law)

(iv) $V \propto n$ or $\frac{V}{n} = $ constant (Avogadro's law)

combination of these gas laws give equation of state for ideal gas,

$$\frac{PV}{nT} = \text{constant} = R$$

$$\text{or. } PV = nRT$$

The equation gives the relation between P, V, T and n of a gas.

(a) **i.** A meteorological balloon is to be filled with helium at atmospheric pressure. What will be the volume of the balloon, if it is to hold all the gas from 25.0 dm^3 gas cylinder at 150 atm? The temperature is constant.

ii. The balloon will burst if its volume exceeds 4000 dm^3. If the filling temperature is 15 °C, what is the maximum temperature, which the balloon can stand at atmospheric pressure.

iii. What will be the volume of balloon if the temperature rises to 19 °C and the pressure falls to 749 mm Hg ?

(b) A container at 250 °C holds 4.0×10^{23} molecules of a gas at 800 torr. The container is illuminated with a light beam that causes molecules to combine and thus reducing their number to 1.0×10^{23} molecules. What is the final pressure in the container. The temperature remains constant throughout.

(c) A very thin 200 mL sealed glass bulb containing a gas at 900 torr is placed in a 1.00 L flask and the empty space inside the bulb which is then filled with the same gas at 60 torr. What would be the pressure inside the flask when the bulb is broken. The temperature is held constant during the experiment.

(d) One theory suggests that, in the formation of our solar system, the contraction of gaseous hydrogen atoms continued until the temperature increased to 2.0×10^{7} °C and the pressure increased to 7.0×10^{9} atm, which are sufficient to start a thermo nuclear reaction. Starting with 1.0 mL of gaseous hydrogen atoms at S.T.P, having a mass of 4.5×10^{-5} g, calculate the density of gaseous hydrogen atoms (i) at STP and (ii) at 2×10^{7} °C and 7×10^{9} atm. Assume that the sample behaves as an ideal gas.

(iii) How many times has the density increased?

Q4. A hypothetical gas obeys the following equation of state:

$$PV^2 = nRT^2$$

(a) What will be the mathematical forms of the followings:
   - (i) Boyle's law (P-V relationship at constant n and T)
   - (ii) Charle's law (V-T relationship at constant n and P)
   - (iii) Gay Lussac's law (P-T relationship at constant n and V)
   - (iv) Avogadro's law (V-n relationship at constant P and T).

(b) What is the value of the gas constant (R), if the molar volume of this gas is 15.0 litres at S.T.P. (273 K and 1 atm)?

(c) Calculate the pressure exerted by 1 mole of this gas at STP in a 15 L container at 100, 140, 170, 200, 250 and 300 K temperature and plot a graph between P and T. Compare this curve with the ideal gas curve.

(d) A 200 litre balloon was filled with this hypothetical gas at 1 atm and at 20°C and then carried to the bottom of marine trench (~ 11km deep) in the Pacific Ocean, where the pressure is about 1000 times greater than the average atmospheric pressure at the surface (1 atm) and the temperature is 15°C. What will be the volume of the balloon at the bottom of the trench?

(e) A metallic spherical laboratory was constructed for the study of the bed of marine trench (temperature 15°C). The laboratory having 25 m^3 dimension was filled with the hypothetical gas at 1 atm and at 20°C at the surface. What changes, if any, would occur in the pressure, volume and temperature of the gas when the laboratory is brought to the bed of the trench?

Q5. In an experiment, hydrogen, oxygen and water in gaseous form are kept in a 1000 litre container at 1000 K.

(a) How many grams of oxygen would you need along with 1000 g hydrogen (g) and 1000 g water (g) to exert 1000 atm pressure?

(b) Assuming that no chemical reaction occurs between the species. Now a spark is passed through the gaseous mixture and after the reaction is completed, the container is cooled to 27°C. What would be the pressure in the vessel at this moment?

Q6. A 1.5 litre vessel contains nitrogen gas saturated with water vapours at 70°C. The total pressure is 740 mm Hg. Now the gas is transferred to

another vessel of volume 780 mL and the temperature is lowered to $20^\circ C$, whereupon most of the water vapour condenses and is removed (Aqueous tension = 195 mm Hg)

(a) What is the total pressure of the gas in the vessel ?

(b) Calculate the number of moles of nitrogen in the vessel ?

Q7. A container of 650 mL capacity contains argon gas at a pressure of 255 torr. Another container of 475 mL capacity contains CO_2 at a pressure of 900 torr. These gases are mixed into another container whose volume is 905 mL. T is constant throughout.

(a) What is the final pressure of the gas ?

(b) What is the mass percentage of each gas ?

Q8. Kinetic molecular theory of gases was proposed in order to explain the behaviour of gases in terms of various gas laws. On the basis of the postulates, the kinetic gas equation can be derived as,

$$PV = \frac{1}{3} mn^1C^2$$

(Where: P and V are the pressure and volume of the gas, m is the mass of one gas molecule n^1 is the total number of gas molecules, C is the root mean square (r, m, s) velocity of the gas molecules).

(a) Derive Boyle's law, Charles' law and Avogadros' law from the kinetic gas equation.

(b) The escape velocity (Ve) from any planet's surface is given by

$$Ve = \sqrt{2gR}$$

where g is the acceleration due to gravity at the planet's surface and R is its radius.

At what temperature the root mean square velocty of hydrogen and oxygen molecules will be equal to the escape velocity from earth For planet earth, $g = 980 \text{ cm s}^{-2}$ and $R = 6.37 \times 10^2$ cm.

(c) (i) Calculate the average kinetic energy per mole for CO_2 gas at $27^\circ C$.

(ii) If the average energy per molecule of CO_2 at $27^\circ C$ is 6.23×10^{-21} J molecule^{-1}, what is the value of Avogadros' constant, N_A.

Q9. Vapour pressure of certain liquids at various temperatures are below:

Temperature ($^\circ C$)	Vapour pressure of Water (torr)	Ethyl Alcohol (torr)	Benzene (torr)
-10	2.1	5.6	15
0.0	4.6	12.2	27
10	9.2	23.6	45
20	17.5	43.9	74
30	31.8	78.8	118
50	92.5	222.2	271
75	284.1	666.1	643
100	760.0	1693.3	1360

(a) Plot the above data on a graph paper to obtain the vapour pressure curves of water/ethyl alcohol/benzene.

(b) From the graph determine the vapour pressure of ethyl alcohol at 25°C and water at 40°C.

(c) Determine the boiling point of water and benzene at 600 and 400 torr respectively.

(d) It is desired to distil ethyl alcohol at 25°C. Can it be done ? If yes, then in what way ?

(e) Which of these liquids has the strongest intermolecular forces of attraction.

(f) Why does water boil in a pressure cooker at a temperature which is more than 100°C ?

(g) The heats of vaporization per gram of these liquids at normal boiling points are given below:

Liquid	Heat of vapourization (J/g)	Normal boiling Point/ ($^\circ C$)
Ethyl alcohol	854	79
Benzene	393	80
Water	2259	100

Does this trend match with your predicted trend ? If not, give reason.

(h) Benzene and ethyl alcohol have nearly equal boiling points and as such their vapour pressure curves should almost coincide with each other and this is observed at high temperatures (above 75 °C). However, at low temperatures the vapour pressure of ethyl alcohol has been found to be very much lower than that of benzene. Assign reason for it ?

Q10. Entropy is a thermodynamic property which is the measure of disorder in a system.

(a) Which state of matter has the minimum entropy ?

(b) What will happen to the entropy of a substance (in any physical state, solid, liquid or gas) when it is heated?

(c) On the basis of entropy consideration, what should be the change in state when a liquid is heated?

(d) At zero kelvin temperature, in a perfectly crystalline solid, all motions of its constituent particles cease. What should be its entropy at this temperature ?

(e) The only case known in which the entropy of a solid substance is greater than its liquid phase at the melting point is a peculiar form of the element helium known as 'helium -3' at temperature below 0.3 K.

Predict the change that occurs when liquid helium - 3 is warmed in the temperature range, 0.1K to 0.3 K.

(f) If we mix two gases at a constant temperature, what will happen to the entropy of the system?

Q11. When an electron is removed from the atom, the atom becomes positively charged.

(a) Which of the positive ions is deflected more in an electric field and explain why?

(i) H^+ or Ne^+

(ii) Ne^+ or Ne^{2+}

(b) Plot the ionisation energy (on the Y axis) of Mg against the ionisation number (on the X axis) corresponding to each of the first 10 ionisation steps. Identify the 1s, 2s, 2p and 3s electrons.

1st	2nd	3rd	4th	5th	6th	7th	8th
Mg^{+}	Mg^{2+}	Mg^{3+}	Mg^{4+}	Mg^{5+}	Mg^{6+}	Mg^{7+}	Mg^{8+}
7.6	15	80	109	141	187	225	266

9th	10th	11th
Mg^{9+}	Mg^{10+}	Mg^{11+}
328	367	1761

Data are given in eV/atom. (eV/atom = 23.06 K cal/mol)

Q12. Arrange in the ascending order of increasing energy of electrons with the following sets of quantum numbers ? Indicate the electronic state also.

	n	1	m	s
(a)	1	0	0	$\frac{1}{2}$
(b)	2	1	-1	$-\frac{1}{2}$
(c)	2	0	0	$-\frac{1}{2}$
(d)	3	2	-1	$\frac{1}{2}$
(e)	3	1	-1	$-\frac{1}{2}$
(f)	3	2	2	$\frac{1}{2}$
(g)	3	1	-1	$\frac{1}{2}$

(h)	3	0	0	$\frac{1}{2}$
(i)	1	0	0	$-\frac{1}{2}$

Q13. For each of the following electronic configurations:

i) Indicate whether a neutral atom, a positive ion, or a negative ion is represented.

ii) Indicate whether the atom is in ground state, excited state or an impossible state. If the state is impossible, explain why ?

(a)	H	$1s^1$
(b)	H	$1s^2$
(c)	Ne	$1s^2\ 2s^2\ 2p^5$
(d)	Ne	$1s^2\ 2s^2\ 2p^4$
(e)	0	$1s^2\ 2s^2\ 2p^4$
(f)	Sc	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$

Q 14. In an investigation of the kinetics of the hydrolysis of methyl acetate catalysed by H^+ ion, aliquot volumes (25 cm^3) of the reaction mixture were titrated against standard alkali solution. The following results were obtained at 35 °C.

Time in min	0.00	10	20	30	40
Volume of alkali solution used.	24.4	25.9	27.3	28.6	47.2

(a) Draw a diagram of a suitable experimental set up for this experiment.

(b) Write the experimental procedure for this experiment.

(c) Calculate average value of the rate constant.

(d) Plot a graph between $\log_{10}$ (a-x) against t.

(e) How will you decide the order of the reaction from steps (c) and (d) ?

Q 15. In an investigation of the conversion of N-chloroacetanilide into p-chloroacetanilidie at 30 °C, the following data were obtained:

Time(hrs.)	0.00	1	2	3	4
Titre value (cm^3)	49.3	35.6	25.8	18.5	13.8

(a) Draw a diagram for the experimental set up for carrying out the investigation.

(b) Plot a graph between t and $\log_{10}(a-x)$.

(c) Write down the experimental procedure for this experiment.

(d) Calculate the rate constant and average specific rate constant of the reaction.

(e) How will you decide the order of the reaction from steps (b) and (d) ?

Q 16. A student investigated the effect of heating varying amounts of manganese (IV) oxide with a fixed mass (5.00 g) of potassium chlorate. The gas was collected by bubbling through water.

Mass of $KClO_3$ = 5.00 g in each investigation

Time required to produce maximum volume of the gas (min)	8	6	5	4	3	2.5
Mass of Catalyst	0.00	0.10	0.20	0.40	0.75	1.0

(a) Draw a diagram of a suitable apparatus for this experiment.

(b) Plot a graph between 1/t and mass of the catalyst used.

(c) What conclusion can we draw from the graph?

(d) What will happen when:

(i) Granual manganese (IV) oxide is used.

(ii) Fine powdered manganese (V) oxide is used

(e) Calculate the volume of oxygen which could be obtained from 5 g of potassium chlorate (under the condition of the experiment). One mole of oxygen molecules occupies 22.4 L.

Q 17. Compare the following three reactions, all of which occur in water solutions.

1. $5C_2O_4^{2-}(aq)+2MnO_4^-(aq)+16H^+(aq)\text{--->}10CO_2(g)+2Mn^{2+}(aq)+8H_2O$.. ....slow

2. $5Fe^{2+}(aq)+MnO_4^-(aq)+8H^+(aq)\text{--->}5Fe^{3+}(aq)+Mn^{2+}(aq)+4H_2O$.....Very fast

3. $Fe^{2+}(aq)+Ce^{4+}(aq)\text{--->}Fe^{3+}(aq)+Ce^{2+}(aq)$ --->Very fast

(a) Why there is a great contrast in the time required for the decolouration ?

(b) Explain why is reaction 1 slow and reaction 2 and 3 are very fast ?

Q18. A student takes 20cm^3 of M/10 oxalic acid solution in three beakers (250cm^3) marked A, B and C separately and then adds 10cm^3 of dil H_2SO_4 in each beaker. He heats solution of the beaker A upto 60-70°C and then titrates against M/10 $KMnO_4$ solution. In beaker B he adds 0.5 g $MnSO_4$ (in powder form) and shakes the solution till it is completely dissolved. Then he titrates this solution against M/10 $KMnO_4$ solution. In beaker C, he adds ice and 1 g $MnSO_4$ (in powder form) and when $MnSO_4$ is completely dissolved, he titrates this solution against M/10 $KMnO_4$ solution.

(a) Write the equation of the chemical reaction which has taken place in beaker A, B and C.

(b) Whether time required for titration in these three cases will be same or different ?

(c) Explain, whether we will get end point in these three experiments.

(d) Whether same amount of $KMnO_4$ will be used in all the three cases? If yes then why?

(e) Whether we will be able to titrate the solution of beaker B and C ? If yes, explain why?

Q19. A student adds 1cm^3 of dil HCl in a beaker containing 20 cm^3 of M/10 sodium thiosulphate solution.

(a) Would you expect any reaction to take place? If yes, write the equation of the reaction ?

(b) After adding HCl in sodium thiosulphate solution, what type of colour of the solution would you expect and why ?

(c) Whether the intensity of the colour will increase with time ? If yes explain why ?

(d) Can you study the rate of this reaction ? If yes explain How ?

Q20. A student performs experiment by adding N-chloroacetanilide into the HCl solution. He gets p-chloroacetanilide.

(a) Write the equation of the reaction.

(b) What is the molecularity and order of this reaction?

(c) Can you study the rate of this reaction? If yes give details of the experimental procedure.

Q21. A Chemist studies the hydrolysis of methyl acetate catalysed by sulphuric acid at 25°C, 35°C, 45°C and 55°C and calculates the specific reaction rate (k) at these temperatures. The average values of k at the above temperatures are as follows:

Temp (°C)	25	35	45	55
Average value of k	$1.32\times10^{-4}\,mm^{-1}$	$7.2\times10^{-4}\,mm^{-1}$	$9.03\times10^{-4}\,mm^{-1}$	$10.00\times10^{-4}\,mm^{-1}$

(Hint: Arrhenius equaton is $k = A\,e^{-Ea/RT}$)

(a) Plot a graph between log k and $\frac{1}{T}$.

(b) From the graph how will you calculate the value of activation energy ?

(c) Discuss the effect of temperature on the reaction rate.

(d) In the above reaction how much increase in the reaction velocity has taken place with the rise of 10°C ?

Q22. Consider the following reaction:

$$C_8H_{18}(1)+12\tfrac{1}{2}O_2(g)\longrightarrow 8CO_2(g)+9H_2O(g) \quad \Delta H = -5498\,kJmol^{-1}$$

The reaction is highly exothermic and can occur with explosive force under the appropriate conditions. However, it does not take place at

room temperature.

(a) Suggest two reasons why molecules must possess a certain energy before reaction between them is possible.

(b) Draw an energy profile to represent the reaction:

$2N_2O(g) \rightleftharpoons 2N_2(g) + O_2(g); \Delta H^0 = -164.0 kJ mol^{-1}$

The activation energy (Ea) for the forward reaction is 250 kJ mol^{-1}.

(Hint: use graph paper and let 1cm represent 50 kJ/mol.)

(c) Use your energy profile diagram to calculate the activation energy for the background reaction.

Q23. An important gas phase reaction, which occurs in the atmosphere, is described by the equation:

$2O_3(g) \longrightarrow 3O_2(g); \quad \Delta H^0_{298} = -283.5 kJ$

A set of experiment gave the following data:

Initial PO_3 (torr)	0.20	0.20	0.40
Initial PO_2 (torr)	0.50	1.0	1.0
Initial rate (torr)	6.0	3.0	12.0

(a) What are the value of x and y in the rate equation

$$\text{Rate} = k\, P_{O_3}^{x}\, P_{O_2}^{y}$$

The reaction was studied in the presence of CO_2 gas to investigate the effect of CO_2 on the reaction rate.

The result of two such experiments at 50°C are as follows:

P_{CO_2} = 100 Torr

t(s)	0	1800	3600	7200
PO_3(torr)	200	140	100	50

P_{CO_2} = 180 Torr

t(s)	0	1800	3600
P_{O_3}(torr)	220	120	70

The complete rate equation for the catalysed reaction is:

$$\text{Rate} = k' P_{O_3}^{m} P_{CO_2}$$

(i) Find the order of the reaction with respect to P_{O_3} for each experiment and the rate constant in each case.

(ii) Does the catalysed reaction have a mechanism different from that of the uncatalysed reaction?

(iii) The rate constant found in part (i) is equal to $k' P_{CO_2}$. Find out the value of k'.

Q24. The development of a photographic image on a film is a process controlled by the kinetics of the reduction of silver halide by a developer. The time required for development at a particular temperature is inversely proportional to the rate constant for the process.

A data on development times for kodak film using kodak D-75 developer is given below:

Temperature (°C)	**Time for Development** (min)
18	10
20	9
21	8
22	7
24	6

(a) Estimate the activation energy for the development process in kJ mol^{-1}. From the graph.

(b) Estimate the development time at 15°C.

Q25. The kinetics of a chemical reaction begins with the experimental determination of the concentration of reactants or products with time. The following experimental data gives the concentration of N_2O_5 measured at the beginning of the reaction (t=0) and at a number of time intervals during the decomposition of N_2O_5.

t(s)	0	423	753	1116	1582	1986	2343
N_2O_5 (mol/L)	1.40	1.09	0.89	0.72	0.54	0.43	0.35

(a) Plot a graph between concentration and time.

(b) Estimate the concentration of N_2O_5 at 600s, 1200s and 1800s from the graph.

(c) From the graph determine the rate of reaction at 600s.

(d) Repeat the calculation of (c) at 1200s and 1800s. Does the rate seem to depend on concentration.

(e) Divide the k values of (c) and (d) by the respective values of $\{N_2O_5\}$ and $\{N_2O_5\}^2$. Is the reaction first or second order?

Q26. In a chemical reaction, reactants are not directly converted to products. The reaction takes place through a series of steps called elementary steps. The rate of the reaction is determined by the slowest step. For the reaction:

$$2A + B \longrightarrow \text{Products}$$

The following data were obtained for a solution containing a large excess of B.

t(s)	0	10	20	30	40	50	60	70
(A) mol/L	10.0	7.95	6.31	5.00	3.92	3.16	2.50	1.99

(a) Calculate log(A) and 1/(A) from the data.

(b) Plot your results from part (a) against t and determine the order of reaction with respect to A.

(c) What is the value of the rate constant?

(d) Which of the following mechanisms are acceptable

(i) $2A + B \longrightarrow \text{Products}$

(ii) $A + B \xrightarrow{\text{slow}} C$

$C + A \xrightarrow{\text{fast}} \text{Products}$

(iii) $A \qquad C$

$C + A + B \xrightarrow{\text{slow}} \text{Products}$

(iv) $A \xrightarrow{\text{slow}} C$

$C + A + B \longrightarrow \text{Products}$

Q27. **Step-I**

A student takes 5 cm^3 of 0.002M potassium thiocyanate solution in three test tubes marked A, B and C. Then he adds in these test tubes, 0.05 cm^3 (one drop), 0.2 cm^3 and 1cm^3 of 0.2 M ferric nitrate solution respectively. Now after shaking these solutions, he compares the colour of the solution of these test tubes in diffused sun light. He finds light red colour in test tube A, dark red colour in test tube B and deep dark red colour in test tube C.

(a) Write the ionic reaction which has taken place in these test tubes.

(b) Why do we get red colour of the solution ?

(c) Why the red colour intensities are different in these test tubes? Explain in detail.

Step-II

Now a small amount of sodium fluoride is added in test tube C and stirred well. Again the colour of the solution is seen in the diffused sun light. He finds that colour of the solution is diluted.

(d) Explain, why the colour of the solution is diluted ?

Q28. **Step-I**

An investigator takes three boiling tubes marked 1, 2 and 3. In each of these boiling tubes he adds 5 cm^3 of 0.005 M Potassium thiocyanate (KCNS) solution. In boiling tube 1, he adds 5 cm^3 of 0.05 M ferric nitrate [$Fe(NO_3)_2$] solution. He gets deep red colour solution.

Step-II

Now he takes 10cm^3 of 0.05 M $Fe(NO_3)_2$ solution in a graduated cylinder and adds distilled water to it upto 50 cm^3 mark. He shakes the solution well. He then takes 5 cm^3 of this solution and pour it into boiling tube 2 and shakes the solution well. He gets light red colour solution.

Step-III

Again he takes 10 cm^3 of the solution $Fe(NO_3)_2$ (step II) in a graduated cylinder and adds distilled water to it upto 50 cm^3 mark. After shaking

this solution, he draws out 5 cm^3 of the solution and pour it into boiling tube 3 and shakes the solution He gets very light red colour solution.

(a) Why are the intensity of the colour of solution in boiling tubes 1, 2 and 3 different? Explain with equilibrium constant equation.

(b) Calculate the concentration of the $Fe(NO_3)_2$ solution of steps-II and III.

(c) What will happen if you add excess of KCNS in boiling tubes 1, 2 and 3 ?

Q29. **Step-I**

An investigator in one experiment mixes hydrogen and iodine in certain proportions and heats the mixture. After some time he gets the following concentrations of the hydrogen, iodine and HI:

Experiment No.	**$[H_2]$ (mol L^{-1})**	**$[I_2]$ (mol L^{-1})**	**[HI] (mol L^{-1})**
1.	2.9070×10^{-3}	1.7069×10^{-3}	10.301×10^{-3}
2.	4.5647×10^{-3}	0.7378×10^{-3}	0.2486×10^{-3}

Step-II

In another experiment he heats HI and gets hydrogen, iodine and hydrogen iodide as follows:

Experiment No.	**$[H_2]$ (mol L^{-1})**	**$[I_2]$ (mol L^{-1})**	**[HI] (mol L^{-1})**
1.	1.1409×10^{-3}	1.1409×10^{-3}	8.410×10^{-3}
2.	0.4789×10^{-3}	0.4789×10^{-3}	3.513×10^{-3}

For Step-I

(a) Write the reaction and equation of the equilibrium constant.

(b) Calculate the value of equilibrium constant for both the experiments 1 and 2

(c) Why is the value of equilibrium constant same in both the experiments 1 and 2 ?

For Step-II

(d) Why in experiment 1 and 2 the concentration of hydrogen is equal to the concentration of iodine (i.e. $[H_2] = [I_2]$) ?

(e) Why is the concentration of HI different in experiment 1 and 2 ?

(f) Calculate the value of equilibrium constant of experiment 1 and 2.

(g) Compare the value of equilibrium constant of step-I and step-II and write your conclusion.

(h) What will happen if pressure is applied in experiments of steps-I and II ?

Q30. An investigator mixes equal volume of 0.01 M $CaCl_2$ and 0.0002 M Na_2SO_4 in first experiment. In second experiment he mixes equal volumes of 0.1M $CaCl_2$ and 0.04 M Na_2SO_4. He shakes both the solutions and observes:

(solubility product of $CaSO_4$ is 2.4×10^{-5}).

(a) Will a precipitate form in either case ?

(b) Explain the reasons for the appearance of the precipitate.

(c) What is solubility product and explain its utility in qualitative analysis

Q31. A student dissolves $BaCrO_4$ in water and shakes the solution for some time. He finds that some of the undissolved $BaCrO_4$ settles down at the bottom.

(Hint: Barium Chromate dissolves to give Ba^{2+} and chromate ions (CrO_4^{2-}. Solubility product of $BaCrO_4$ is 8.5×10^{-11}).

(a) What happens when barium chromate is dissolved in water ?

(b) Write the solubility product expression.

(c) Calculate the solubility of $BaCrO_4$ in moles per litre.

Q 32. During qualitative analysis is student prepares solution of the mixture in dil or conc HCl. But before passing H_2S gas for precipitation of group-II cations he adds excess of water in the solution. Whereas for the precipitation of group-IV cations he makes the solution ammoniacal by adding excess of NH_4OH solution in the acidic solution.

(a) Why for the precipitation of group-II cations excess of water is added in the original solution ?

(b) Why do group-II radicals precipitate in the presence of acidic medium ?

(c) For the precipitation of group-IV cations excess of NH_4OH solution is added into the filtrate of group-III solution. Explain why ?

Q 33. A student adds 5 cm^3 of 0.02 M acetic acid solution into 5 cm^3 of 0.1M sodium acetate solution. After shaking the solution he pours 2 cm^3 of this solution in three marked test tubes 1, 2 and 3. In test tubes 2 and 3 he adds 0.1cm^3 of dil HCl and 0 1cm^3 of NH_4OH solution respectively. He shakes these solutions well.

(Hint: (pH of the solution of test tubes 1, 2 and 3 remain the same and ionisation constant for acetic acid is $1\ 8 \times 10^{-5}$)

(a) Why does the pH of the solution of test tubes 1, 2 and 3 remain the same ? Give a detailed explanation.

(b) When acetic acid solution is added into sodium acetate solution, what reaction takes place ?

(c) Calculate the H_3O^+ concentration of this solution.

Q 34 When NO and Br_2 combine, nitrosyl bromide is formed·

$$2NO(g) + Br_2(g) \longrightarrow 2NOBr$$

But nitrosyl bromide easily dissociates even at room temperature

$$NOBr(g) \rightleftharpoons NO(g) + \frac{1}{2}Br_2(g).$$

(a) What will be the maximum yield of NOBr, if we take 3.5 g of NO and 9.67g of bromine?

(b) Draw the electron dot structure of nitrosyl bromide.

(c) Suggest its molecular geometry

(d) A small amount of NOBr is placed in a flask at 25°C and it is allowed to dissociate. The total equilibrium pressure is 190 mm Hg and the compound is found to be 34% dissociated. Calculate the value of Kp.

Q35. A student studies the following equilibrium reaction at constant temperature and constant volume.

$$AgCl(s) \rightleftharpoons Ag^{+}(aq) + Cl^{-}(aq)$$

(Hint: $K_c = 1 \times 10^{-10}$ and H = +15.7 k Cal.)

(a) What will be the effect of the following changes at the equilibrium point?

  (i) If Ag^{+} and Cl^{-} ions are added.

  (ii) If Ag^{+} and Cl^{-} are removed.

  (iii) If the temperature is increased.

  (iv) If water is added and thereby decreasing the concentration of Ag^{+} and Cl^{-} .

(b) If AgCl(s) and Cl^{-} ion are added, what will be the effect on the number of moles of Ag^{+} at equilibrium?

(c) What will be the effect on the concentration of Ag^{+} at equilibrium if Cl^{-} and AgCl(s) are added ?

Q36. Suppose oxygen gas is kept in contact with water in a closed compartment A equilibrium is maintained between the oxygen gas and its aqueous solution. The solubility of oxygen gas in water at different pressure and at a given temperature are as follows:

O_2 Pressure kPa	$O_2(g)$ mol L^{-1}	$O_2(aq)$ Mol L^{-1}	$\left[\frac{O_2\,aq}{O_2\,g}\right]_{eq}$
106.4	0.043	0.0012	0.0288
199 6	0.080	0.0023	0.029
333.3	0 130	0.0038	0.029
466.1	0 190	0.0053	0.028
598.8	0.240	0.0067	0.028

(a) What will be the rate of dissolution of gas and the rate of its escape when the pressure above the solution is increased ?

(b) Will the system be in equilibrium ?

(c) How will you compare the concentration of dissolved gas with that of the original system when equilibrium is reattained ?

(d) Is there any law which governs the dependence of pressure on solubility ? Also explain its limitations.

Q37 The effect of temperature and pressure on the equilibrium concentration of the reaction product A in gaseous state in the forward reaction is given below.

Temperature	**% of A in the equilibrium mixture**		
(°C)	**(1 atm)**	**(100 atm)**	**(200 atm)**
550	0.077	6.70	11.90
650	0.032	3.02	5.71
750	0.016	1 54	2.99
850	0 009	0.87	1.68

(a) Whether the formation of the product A is associated with the increase or decrease of volume?

(b) Whether the forward reaction is exothermic or endothermic ?

(c) Mention the theoretical optimum condition in terms of pressure

and temperature for the formation of A at a large scale.

Q38. Bromine water is brown in colour and it is slightly acidic due to the following reaction:

$Br_2(aq) + H_2O(l) \rightleftharpoons HBrO(aq) + H\ (aq) + Br^-\ (aq)$

In aqueous solution, Br_2(aq) is brown but HBrO(aq) and Br^- (bromide ions) are colourless.

(a) Explain why does a sample of bromine water becomes colourless when sodium hydroxide is added to it but the brown colour reappears when HCl is added ?

(b) Can bromine water be used as an indicator in acid-base titration ?

Q39. Consider the following reactions:

(a) $Cu(s) + 2Ag^+(aq) \longrightarrow 2Ag + Cu^{2+}(aq)$

(b) $4P + 6NaOH \longrightarrow PH_3 + 3Na_2HPO_2$

In reaction (a) we see that oxidation number of copper changes from zero to 2+ and that of silver changes from 1^+ to zero, we say that copper (O) is oxidised to copper (II) and silver (I) is reduced to silver (O). In other words we also say that silver (I) oxidises copper (O) to copper (II) and copper (O) reduces silver (I) to silver (O).

Further, in reaction (b) we observe that oxidation number of phosphorus in elemental phosphorus is zero, in PH_3 it is 1^+. We call the reaction (b) as disproportionation reaction or auto oxidation-reduction reaction.

During manufacture of sodium, the electrolysis of fused sodium chloride is carried out in an electrolytic cell where anode acts as centre of oxidation and cathode acts as centre of reduction.

(a) Define the terms 'Oxidation' and 'Reduction' in terms of loss and gain of electrons and changes in oxidation numbers.

(b) How are the definitions of oxidizing agent and reducing agent in terms of transfer of electrons and change in oxidation number

from the definition of oxidation and reduction.

(c) What is disproportionation reaction? Will the following reaction be a disproportionation reaction. If yes, give reason:

$$3Au^{+} \longrightarrow 2Au + Au^{3+}$$

(d) Where will be sodium metal deposited during electrolysis of fused sodium chloride, at the anode or at the cathode?

(e) What are anodic oxidation and cathodic reduction? Substantiate it by taking the electrolysis of fused alumina during extraction of aluminium as an example.

Q40. A strip of copper is cleaned with a sand paper and washed. It is then immersed in silver nitrate solution taken in a beaker. After an hour it is observed that a change over the surface of copper metal has occurred. Also a change in colour of the solution in which strip of copper has been dipped, is observed. A galvanic cell is constructed using the two metals copper and silver as electrodes.

(Hint: $E^{o}_{Ag^{+}/Ag} = 0.80V$; $E^{o}_{Cu^{2+}/Cu} = 0.34V$

(a) What changes do you expect to occur over the surface of copper metal and in silver nitrate solution ? Explain.

(b) Write down the ionic equations when copper strip is dipped into a silver nitrate solution.

(c) Which metal should act as anode and which should act as cathode while constructing the galvanic cell.

(d) Write down the two half-reactions occurring at the two electrodes in the galvanic cell.

(e) How will the two half cells be connected to make electrical contact between them.

Q41. The reversible e.m f of a cell, E^{o}_{cell}, is a measure of the decrease in Gibb's free energy for the cell reaction.

$$\Delta G^{o} = -nFE^{o}$$

For a reaction to occur spontaneously, the standard free energy should be negative. In other words for a reaction to occur spontaneously, the

e.m.f. of the cell should be positive.

The standard electrode potentials of thallium and its ions in acid solution are given as:

$$\begin{tikzcd} Tl^{3+} \arrow[r, "+1.25V"] \arrow[rr, bend right, "+0.72"'] & Tl^{+} \arrow[r, "-0.34V"] & Tl \end{tikzcd}$$

Which means that

$$Tl^{3+} + 2e^- \longrightarrow Tl^+ \quad , E^0 = \; + 1.25V$$

and so on. Further, standard reduction potential of Cl_2/Cl^- couple is +1.36 V.

(a) Is Tl^+ stable towards disproportionation in water solution ?

(b) Which ion is produced when Tl metal reacts with H^+ (aq).

(c) Will Tl react with Cl_2 ? What is the product ?

(d) Write down the balanced equations for all the reactions.

Q 42. The galvanic cell containing two H^+ / H_2 half cell, having $[H^+]$ as 0.0250 M in left hand half cell and 5.00 M in the right hand half cell as shown below :

$$Pt \,|\, H_2\,(g),\; H^+\;(0.0250\;M) \;||\; H^+\;(5.00M),\; H_2\,(g) \,|\, Pt$$

(a) Calculate the e.m f. of the above cell when pressure of H_2 (g) in both half cells is 1.00 atm.

(b) Determine the e.m.f. of the cell if the pressure of H_2 (g) is changed to 2.00 atm., in the anode half cell and to 0.100 atm. in the cathode half-cell.

(c) Write an equation for the 'cell reaction.

Q 43. A galvanic cell is represented as :

$$Zn(s) \,|\, Zn^{2+}\,(aq)\;(0\;1M) \;||\; Cu^{2+}\,(aq)\;(0.01\;M) \,|\, Cu$$

The cell works at a temperature of 298 K

It is also given that $E^0_{Zn^{2+}/Zn}$ = -0.76 V and $E^0_{Cu^{2+}/Cu}$ = + 0.34 V.

(a) Draw a sketch of the galvanic cell as represented above.

(b) Name the electrodes which will work as negative and positive electrodes.

(c) What is the mode of establishing electrical contact between the two half cells.

(d) What will the voltmeter reading indicate when saltbridge is withdrawn from the galvanic cell.

(e) Calculate the electrode potentials of the oxidation half cell and reduction half cell.

(f) What will be the e.m.f. of the above cell when the concentration of both Zn^{2+} (aq) and Cu^{2+} (aq) becomes 1 molar.

Q 44. **Step-I**

Lacs of rupees worth of valuable materials are destroyed by corrosion. Corrosion is most familiar in the form of rusting. The corrosion of metals is an oxidation process. The reaction of atmospheric oxygen with iron is very slow but over a requisite period of time iron oxidizes to rust. Rusting becomes faster when the metal is in contact with water. Even moisture and water vapours accelerates the process of rusting.

(Hints . The chemical reaction occurring during rusting is :

Oxidatioin :

$$Fe \longrightarrow Fe^{2+} + 2e^- , \quad E^0 = +0.41\ V$$

Reduction :

$$\frac{1}{2}O_2 + H_2O + 2e^- \longrightarrow 2OH^- , \quad E^0 = +0.40\ V$$

Moist air

Overall reaction :

$$Fe + \frac{1}{2}O_2 + H_2O \longrightarrow Fe(OH)_2 , \quad E^0 = +0.81\ V$$

The initial product, $Fe(OH)_2$ is further oxidized by moist air to Fe $(OH)_3$ (ferric hydroxide), which rapidly looses water and is converted to Fe_2O_3.

$$2Fe(OH)_2 + \frac{1}{2}O_2 + H_2O \longrightarrow 2Fe(OH)_3$$

$$2Fe(OH)_3 \longrightarrow Fe_2O_3 . 3H_2O$$

(a) Name the essential conditions for rusting of iron and the final product when iron rusts.

(b) -- Why is rusting accelerated in presence of water or moisture ?

(c) Is rusting of iron and oxidation process on redution process ?

Step-II

Further, iron oxide does not stick to the iron surface because of dissimilar structures of iron and iron oxide. Thus, the iron oxide formed flakes off the iron surface, exposing a fresh surface of iron to the atmosphere. The exposed fresh surface of iron gets further attacked by oxygen and water vapours leading to rusting of iron.

Iron will not oxidize or rust as long as there is a more reactive metal whose reduction potential is more negative. Aluminium is a good choice for electrochemical protection of iron. Iron is protected from rusting by coating its surface with aluminium. When aluminium oxidizes, it forms aluminium oxide having similar crystal structure to the pure aluminium. As such Al_2O_3 formed sticks to the surface of aluminium. In this way aluminium surface is protected from further oxidation

Since iron lies below the surface of aluminium, hence it will be protected from rusting.

(d) Suppose a metal M has more negative reduction potential value than iron and is used as electrochemical protection of iron, Explain how iron will be protected from the metal M from corrosion or rusting ?

(e) Iron oxide forms an iron surface during rusting. Aluminium oxide gets deposited on iron surface when iron surface is coated with aluminium. Why is it so that iron oxide does not protect iron from further rusting whereas formation of Al_2O_3 layer on iron surface protect iron from further rusting ?

Step -III

Till now we have seen that aluminium metal is used as protecting metal against rusting. But zinc metal is used as protecting metal also. Protecting metal from corrosion by coating the surfaces with zinc is called galvanizing. zinc oxidizes to zinc oxide which is converted by atmospheric CO_2 to carbonate which sticks to the surface of the zinc metal. Some rusting inhibitors such as chloride ions or tributylamine are used to protect metals from rusting.

(f) What is galvanized iron sheet ? What is its advantage over ordinary iron sheet ? Explain the role of protecting metal against corrosion in galvanized iron sheet.

(g) Why are the covering of metal by layers of paints, grease, referred to as a temporary technique for protecting metals ?

Q 45. For each of the following redox reaction, write two balanced equation each involving electron transfer, one for the oxidation process and another for the reduction process stating in each case which equation describes oxidation and which reduction. Then write down the complete balanced equation.

(a) Write reaction between $Cr_2O_7^{2-}$ and Fe^{2+} in aqueous solution in the presence of H^+ .

(b) Write reaction between Cl_2 and I^- in aqueous solution.

(c) Write reaction between Li and H_2.

Q 46. When potassium iodide solution is added to copper sulphate solution, orange yellow coloration appears which turns to violet on adding starch solution. The violet colour disappears when excess of sodium thiosulphate is added.

(a) Write down all the balanced chemical reaction on the basis of above observations. Give reasons for the appearance of organe-yellow coloration and violet colour.

(b) Decide which species will act as oxidizing agent and which will act as reducing agent.

(c) What are the oxidation numbers of the effective element of the oxidizing and reducing agents.

(d) Also work out the equivalent weights of sodium thiosulphate, copper sulphate and iodine in terms of its molecular weight.

Q.47. An electrochemical cell ·

$$Pt(H_2, 1\ atm)\ \big|\ HNO_3\ (M=1),\ AgNO_3\ (M=1)\ \big|\ Ag$$

is set up to 298 K. State the e.m.f. of the cell and its polarity in an open circuit. What chemical changes begin to occur if it is connected across a high resistance.

The following cell is set up to observe electrolysis at 298 K.

$$\text{Pt}\ (H_2,\ 1\ \text{atm})\ \Big|\ HNO_3\ (M=1),\ Cu(NO_3)_2\ (M=1)\ \Big|\ \text{Cu}$$

What is minimum voltage which must be applied and of what polarity to cause deposition of copper on the copper electrode ?

How does the situation differ if :

(a) The left hand electrode is not as shown but is made of Pt with no supply of hydrogen.

(b) The left hand electrode is made of silver with no supply of hydrogen.

(c) The electrodes are as shown but the electrolyte is diluted by a factor of ten ?

(given : $E^o_{Ag^+/Ag}$ = + 0.799 V, $E^o_{Cu^{2+}/Cu}$ = + 0.337 V)

Q 48. The following electrodes are coupled :

(i) $Zn^{2+}(aq) / Zn$; E^o = -0.762 V and

$Hg^{2+}(aq) / Hg$, E^o = + 0.792 V

(ii) $Pt, I_2/I^-$ (aq), E^o = + 0.54 V and

$H_2(g)/Pt, H^+$ (aq); E^o = 0.00

For each cell :

a) Predict each electrode reaction and the cell reaction.

b) Predict at which electrode, oxidation and at which electrode reduction occurs. Which electrode is the anode ?

c) Calculate the standard e.m.f. of each cell E^o_{cell} .

Q-49 Experimentally, E (change in internal energy) can be measured by using a device called a 'bomb calorimeter'. At 25 °C, burning 0.200 mole of H_2 with 0.100 mole of O_2 to produce H_2O (1) in a bomb calorimeter raises the temperature of the apparatus by 0.880 °C. When 0.100 mole of toluene (C_7H_8) is burnt in this calorimeter, the temperature is raised by

0.615°C. ΔH_f^o for H_2O (l) is -68.3 k cal/mol

a) Draw a labelled diagram of 'bomb calorimeter'.

b) Write thermochemical equation for the combustion of liquid toluene forming CO_2 (g) and H_2O (1).

c) Calculate ΔE for this reaction in kilo jules.

d) Calculate ΔH_f^o for toluene assuming that the reaction was carried out at 25°C.

Q.50. Diamond is a simple allotrope of carbon. Since 1797, experiments were devised to convert graphite, the common form of carbon, into diamond. However till 1938, no achievements were made. In 1938, a careful thermodynamic analysis was carried out which are shown in the figure-3 below. This analysis served to define the limits of temperature and pressure that would permit the conversion to take place. In fact after 1995, the success was finally achieved and today synthetic diamonds are an important industrial abrasive used in grinding and cutting tools.

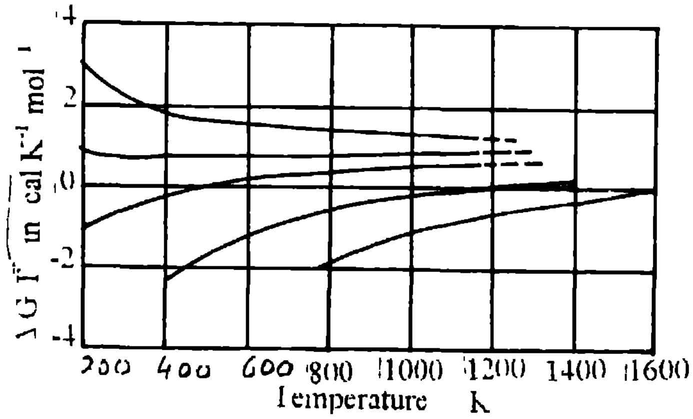


Fig.3

a) What is the thermodynamic condition for the spontaneity of this reaction ?

b) What is the temperature beyond which graphite cannot be converted into diamond, if the pressure is kept constant at 20,000 atm.

c) What is the minimum pressure necessary for the conversion of graphite to diamond at a temperature of 200 K ?

d) Is it theoretically possible to change graphite to diamond at one atmospheric pressure ?

Q.51 The thermal energy produced by different fuel depend in their respective heat of combustion. Gasoline (Octane) and hydrogen both can independently be used as a source of thermal energy. At 25°C, octane is a liquid with density 0.703 g/mL and its heat of combustion is -5520 kJ/mol. ΔH_f^0 for water is -286 kJ/mol.

a) Write the thermochemical equations for the combustion of octane and hydrogen.

b) Calculate the number of kilo jules liberated during the combustion of 3.79 L of octane (gasoline).

c) What weight of hydrogen would have to be burnt, giving H_2O (1), to produce the same amount of heat ?

d) What will be the volume of this gas(hydrogen) at 25°C and 170 atm pressure ?

e) What does this suggest about the feasibility of hydrogen being used as a fuel for producing thermal energy ?

Q.52. The heat of combustion of glucose is 2820 kJ/mol. It is estimated that the body, by the above process, generates upto 5900 kJ of thermal energy per hour during heavy physical exercise ad this excess energy could be dissipated only through the evaporation of water present in the body

a) What is the name of the metabolism in the body process which gives energy ?

b) Give a thermochemical equation for the above process.

c) How many grams of water would evaporate per hour to keep the body temperature constant

d) If it is assumed that 60% of the available energy appears as excess body heat (the remaining 40% is used by the body to do mechanical work in moving of limbs, pumping of blood etc.), how many grams of glucose would have to be used per hour in order to generate

the excess thermal energy.

Q.53. The heats of formation of gaseous carbon and hydrogen atom from these elements in their standard state are 715 kJ/mol and 218 kJ/mol respectively. The average bond energies for different bonds are as follows:

Bond	Bond energy in kJ/mol.
H-C	415
C-C	348
C=C	607

a) Calculate ΔH_f^0 for benzene in kJ/mol from the above data.

b) The experimental values for the heat of combustion of hydrogen (g), carbon (graphite) and benzene (g) are found to be 57.8 k cal, 94.1 cal and 757.7 k cal respectively. Calculate ΔH_f^0 for benzene in kJ/moL from the above values.

c) Compare the calculated value of (a) with the experimental value of (b). Write your conclusions.

d) How does the difference of energy between steps a and b account for the stability of benzene?

Q.54. In the graphs given [Fig. 4(a), 4(b) and (4)c] below 'R' represents the reactants ad 'P' represents the product.

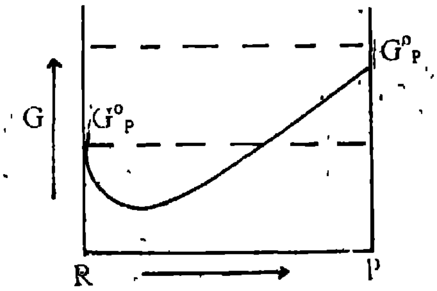


Fig. 4(a)

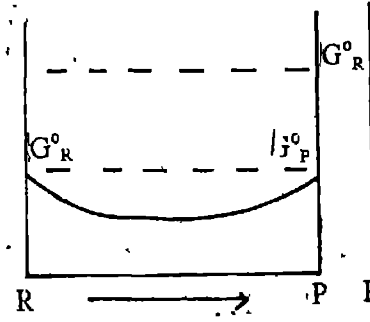


Fig. 4(b)

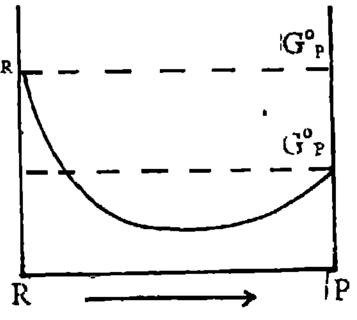


Fig. 4(c)

a) Draw a line in the above graphs to show the position of equilibrium.

b) What inference can be drawn regarding ΔG^0 values in the above graphs ?

c) What is the relationship between ΔG^0 and position of equilibrium

in the above figures ?

d) What inference can be drawn regarding the reaction from the position of equilibrium ?

e) What is the relationship between ΔG^0 and the rate with which the products of a reaction are formed ?

Q.55. The first ionization energy of gaseous sodium atoms is 494 kJ/mol and adding electrons to gaseous chlorine atoms to form gaseous chloride ions liberates 351 kJ/mol. The heat of formation of gaseous Na and Cl atoms and NaCl(s) is -108 kJ/mol, -121kJ/mol and 413 kJ/mol respectively

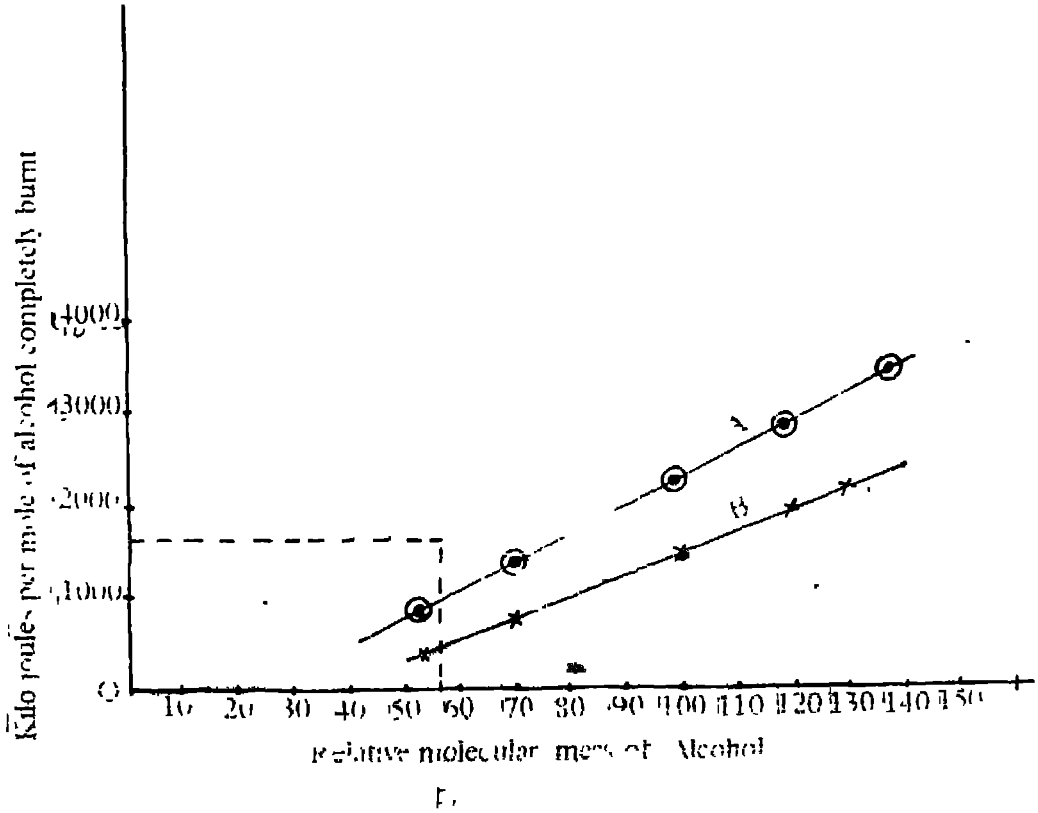
a) Write thermochemical equations for all the processes mentioned above

b) Calculate ΔH (in kJ) for the reaction :

$$NaCl(s) \longrightarrow Na^+ + Cl^-$$

c) What is the energy change corresponding to equation in (b), and why ?

Q56 A graph shown below depicts the heat of combustion for a number of different alcohols



a) Find out the heat of combustion of ethanol from graph 'line A'.

b) Draw the diagram of a simple apparatus which can be used in the laboratory to measure the heat of combustion of alcohols

c) A student performs a series of experiment with the above apparatus to measure the heat of combustion of different alcohols and plot a graph as shown in graph (fig. 5) 'line B'

It can be seen from the graph (fig. 5) that the experimental values of the heat of combustions are very much lower than the accepted values

i Give three reasons why this is so ?

ii. Give suggestions for the modification of the apparatus so that the results may be improve

Q.57. A man sits still in a warm room and eats ½ kg of cheese (an energy intake of 4000 kJ). Supposing that none of the energy is stored in body, what mass of water would be needed to perspire in order to maintain his original temperature.

(Hint : molar enthalpy of vaporization of water is 44 016 kJ mol) at 298 K)

Questions
on
Organic Chemistry
(Class - XI)

Q.1. Three organic molecules A, B and C have structures :

$H_2C = CH\text{-}CH_2\text{-}C \equiv CH$ (A) $H_2C = CH\text{-}CH{=}CH_2$ (B) $HC \equiv C\text{-}C \equiv CH$ (C)

a) Give their IUPAC Names.

b) Give the type of hybridisation of each carbon atom in A,B and C.

c) Which are the most acidic hydrogens in these molecules.

d) Which one of the three molecules would polymerise most readily ?

e) Write structure of the products obtained when A, B and C react with sodamide in ether solution separately.

f) Which carbon in A has minimum 's' Character ?

Q.2. Study the following reactions

$$\begin{tikzcd} CH_3CH_2Cl \arrow[r, "aqKOH", "(i)"'] \arrow[d, "(ii)\ Ethanolic\ KOH"] & CH_3\ CH_2OH \\ CH_3CH_2O\ CH_2CH_3 + CH_2 = CH_2 & \end{tikzcd}$$

a) What are the attacking ions in reactions (i) and (ii). Are these nucleophiles or electrophiles ?

b) Are the reactions (i) and (ii) substitution, addition or elimination ?

c) In reaction (ii) diethyl ether and ethylene are formed from the same or different reaction intermediates ?

d) Why ethylene is not formed in reaction (i).

Q.3. An experiment was set up as shown in the Fig 6.

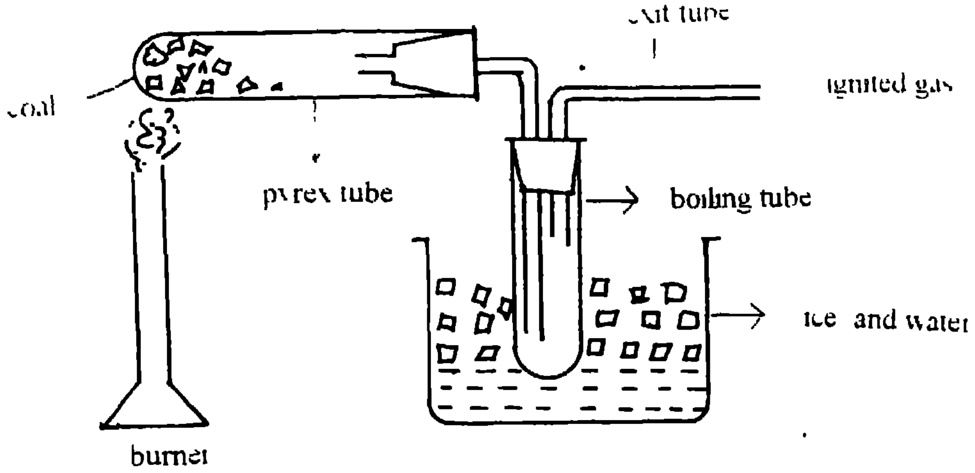


Fig. 6

A student was asked to heat the coal powder in pyrex tube strongly and record his observations at the exit tube. His observations were as follows :

i) When a piece of filter paper moistened with lead nitrate solution was held at the exit, it turned black.

ii) After sometime when air was expelled from the apparatus, the issuing gas at the exist was ignited. It burnt with a non-smoky luminous flame.

III) After the experiment the boiling tube contained two layers an upper columnless and the lower dark black liquid.

a) What can be the possible composition of the issuing, gas ? What is this gas known as ?

b) Is the issuing gas similar to gases present in LPG (liquified petroleum gas) ?

c) Why does lead nitrate paper turns black ? write the chemical equation for this reaction

d) The observation under heading (a) is indicative of the presence of a special class of organic compounds in coal, what types are these compounds and what is their origin ?

e) The upper layer in the boiling tube should be acidic or alkaline ?

Which compound is responsible for its acidity or alkalinity ?

f) What is the name given to the lower black viscous layer in the boiling tube? Give its chemical composition

g) What is the residue left in pyrex tube known as ? What is its main application?

Q.4 An experiment was set up as shown in the Fig 7

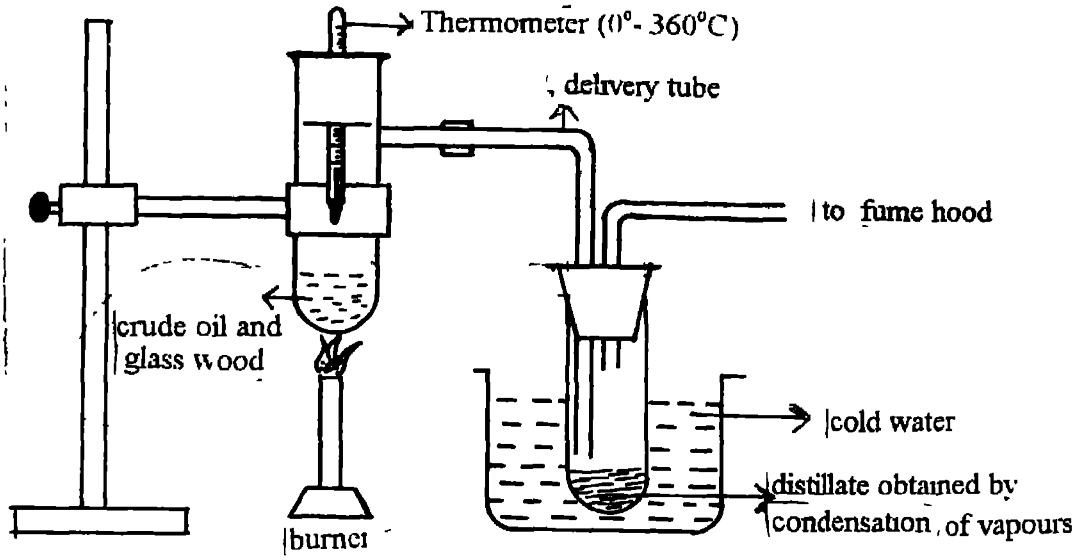


Fig.7

The distillation tube was heated and following fractions were collected, each in separate test tube.

Fraction (i) (boiling below 70°C)

Fraction (ii) boiling between 70°-130°C)

Fraction (iii) (130°-180°C)

Fraction (iv) (180°-240°C)

Fraction (v) (240°-320°C)

Fraction (vi) (above 320°C) -(Residue left)

a) The boiling point of pentane is 36°C, hexane 69°C and heptane 98°C and constantly increases by 25°-28° C for each next higher homologue. Based on this write the possible composition of each fraction obtained as above.

b) What is the commercial name for each fraction and mention its main applications.

c) The process by which higher boiling fractions change into lower boiling ones is known as .... ?

d) The commercial process by which straight chain hydrocarbons are converted to branched chain hydrocarbons or to cyclic hydrocarbons is known as ....

e) How does the distillation of crude oil differ from destructive distillation of coal ?

f) Compare the composition of coal with crude oil.

Q.5. Three samples of gasoline have octane numbers 80,85 and 97 respectively. Their ignition (knocking) matches with three litre mixtures of heptane and iso-octane labelled as A,B and C.

a) Findout the exact volumes of heptane and iso-octane in A,B and C solutions.

b) Write down the chemical formula for iso-octane. Give its IUPAC name. Why the name iso-octane is incorrect ?

c) Why addition of tetraethyl lead to gasoline increases its octane number ?

d) The approximate composition of three gasoline samples are given below :

i) $CH_3(CH_2)_4CH_3 + CH_3CH(CH_3)(CH_2)_2CH_3 + CH_3(CH_2)_5CH_3$

ii) $CH_3(CH_2)_5CH_3 + (CH_3)_2CH\,C(CH_3)_2CH_3 + (CH_3)_3CCH_2CH_3$

iii) $CH_3(CH_2)_6CH_3 + CH_3(CH_2)_5CH_3 + CH_3(CH_2)_4CH_3$

Which one of these will have lowest octane number.

Q.6. An organic compound (A) responds to following tests :

i) $A \xrightarrow{Na_2O_2\text{ (fuse) / }H_2O} \text{An inorganic acid derivative}$

$\downarrow$ conc HNO_3 + amm. molybdate

yellow ppt

ii) Lssaigne's solution of (A) + $FeSO_4$ + $H_2SO_4 \rightarrow$ Red colour

iii) $A \xrightarrow{HNO_3\text{ (fuming) } (\Delta)\ /\ \text{Magnesia mixture/ignition}} Mg_2P_2O_7$

iv) $A \xrightarrow{\text{conc } H_2SO_4\ (\Delta)\ /\ NaOH\text{ (excess)}}$ colourless gas (gets absorbed in H_2SO_4)

v) Lassaigne's solution of (A) + HNO_3 + $AgNO_3$ → White ppt $\xrightarrow{NH_4OH}$ soluble

a) What are the elements likely to be present in the given organic compound.

Give equations and explain reactions in the test No's.(i) to (v).

b) If an organic compound has N, S and Br in its molecule what should be the composition of its Lassaigne's solution.

c) Why fusion with sodium metal is necessary for detection of elements in organic compounds ? Can potassium metal be used for fusion ? If not why ?

Q.7. Suppose the energy obtained by metabolic breakdown of 10 g of glucose is sufficient to carry out physiological activity of a living body for 30 minutes,

a) How many grams per hour should be the intake to maltose to maintain similar activity for 1hr. (if hydrolysis of maltose is complete).

b) How many grams per hour should be the intake of lactose for maintaining equal activity for 1 hr (if galactose is taken not to undergo any breakdown).

c) How many grams per hour should be the intake of sucrose for double the above mentioned activity for 1 hr (if fructose does not contribute to release of energy).

d) Why the products obtained on hydrolysis of sucrose known as 'invert sugar' ? Is this inversion same as walden inversion ? If not what is the difference ?

e) Taking example of glucose explain mutarotation.

f) Write chemical structures of maltose, lactose and sucrose (ring structures). [hint : Lactose is 4-0-β-D- galactopyranocyle-D–

glucopyranose, maltose is 4-0-α- D- glucopyranosyl-D-glcopyranose and sucrose is α--D--glucopyranosyl- β-D fructo furanoside.]

.8. a) If complete combustion of a gram mole of glucose liberates 'X' kilo-joules' of energy, how much energy would be released by complete combustion of the hydrolysis products obtained from different samples of starch $C_n (H_2O)_{n-1}$ having values of 'n' as (i) 96, (ii) 108 and (iii) 120 and from different samples of cellulose having values of 'n' as (i) 180, (ii) 198 and (iii) 258.

b) Both starch and cellulose are polymers having glucose as the monomeric unit. Give the main difference in the structures of the two polymers.

c) Can enzymes differentiate between the type of glucosidic linkages present in starch and cellulose ?

.9. The following is the segment of DNA, specifying the triplets (codous) translating into different amino acids.

DNA $\longrightarrow$ 5′ CTG-GTG-TGA-ACC-CTT3'

Protein : aa_1 ____ aa_2 ____ aa_3 ____ aa_4 ____ aa_5

a) In a segment of protein the sequence of amino acids is.

aa_3 ____ aa_1 ____ aa_5 ____ aa_2 ____ aa_4 ____ aa_1 ____ aa_2

What should be the sequence of bases in the corresponding segment of DNA (from 5' to 3' end)

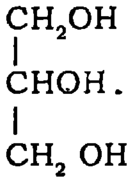
b) Write the sequence of the segment of RNA complementary to the DNA sequence given above under (a)

c) Write the sequence of the strand of DNA complementary to the segment given under (a)

d) Draw the structure of double helix of DNA i.e with complementary strand of the segment of DNA given above in (a) and (c)

e) Show the replication process with the double helix of DNA drawn under (d) Do the two daughter helix have the same sequence as the parent helix ?

Q.10. Study the molecular structures given below ;



$$\begin{array}{l} CH_2OH \\ | \\ CHOH. \\ | \\ CH_2\ OH \end{array}$$

(i)

$C_{17}\ H_{35}\ COOH$

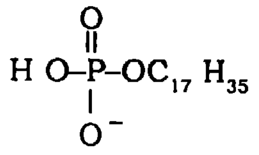
(ii)

$C_{17}H_{33}\ COOH$

(iii)

$C_{15}H_{31}\ COOH$

(IV)



$$H\ O-\underset{\underset{O^-}{|}}{\overset{\overset{O}{\|}}{P}}-OC_{17}\ H_{35}$$

(V)

$CH_3\ (CH_2)\ _{29}OH$

(VI)

(myricyl alcohol)

a) Give chemical names for (i), (ii), (iii) and (iv) and IUPAC name for (i).

b) Write molecular structure for (i) Triolein (trioleate ester of glycerol) (ii) $\alpha\ \alpha'$ - Di-Strearate-β monooleate of glycerol (iii) $\alpha,.\ \alpha'$-Dipalmitate -β monostearate of glycerol.

c) Write molecular structures for sodium stearate, aluminium-palmitate and magnesium oleate. What is the commercial name for these compounds ?

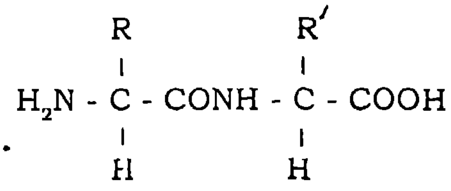
d) Write molecular structures for myricyl- stearate and myricyl-palmitate. What are these compounds commonly known as ?

e) Write molecular structure of α stearate-β palmitate- α^1 - phosphostearate of glycerol. To which class of biomolecules, this molecule belong ? Give its major function in bio-systems.

f) Name the product obtained on catalytic hydrogenation of triolein. Is there any phase change in this reaction ? Give commercial importance of this reaction.

g) (a) 'iii' on ozonolysis gives two aldehydes (i) nonanal and (ii) azelaic half aledhyde [OHC $(CH_2)_7$ COOH]. Write its molecular structure assigning position to double bond.

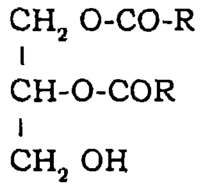
Q.11 a) Name the functional groups present in the following compounds : :



$$H_2N - \underset{H}{\overset{R}{C}} - CONH - \underset{H}{\overset{R'}{C}} - COOH$$

R, R' = alkyl groups

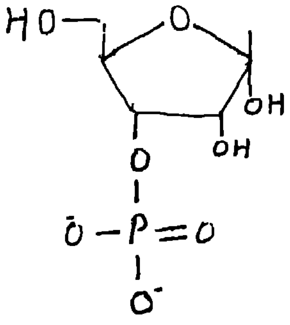
(i)



$$\begin{array}{l} CH_2\ O\text{-}CO\text{-}R \\ | \\ CH\text{-}O\text{-}COR \\ | \\ CH_2\ OH \end{array}$$

R= alkyl group

(iii)



(ii)

b) Give one method of formation of peptide and ester bonds.

c) Differentiate between alkaline hydrolysis and saponification.

d) Differentiate between aimde and peptide linkages.

e) What is the importance of phosphate bonds in living systems ?

f) Write structure of α-D glucose -6- phosphate.

Q.12. A graph showing variation in m.p's and b.p's of n-alkanes with increase in the number of carbon atoms in their molecules is given below :

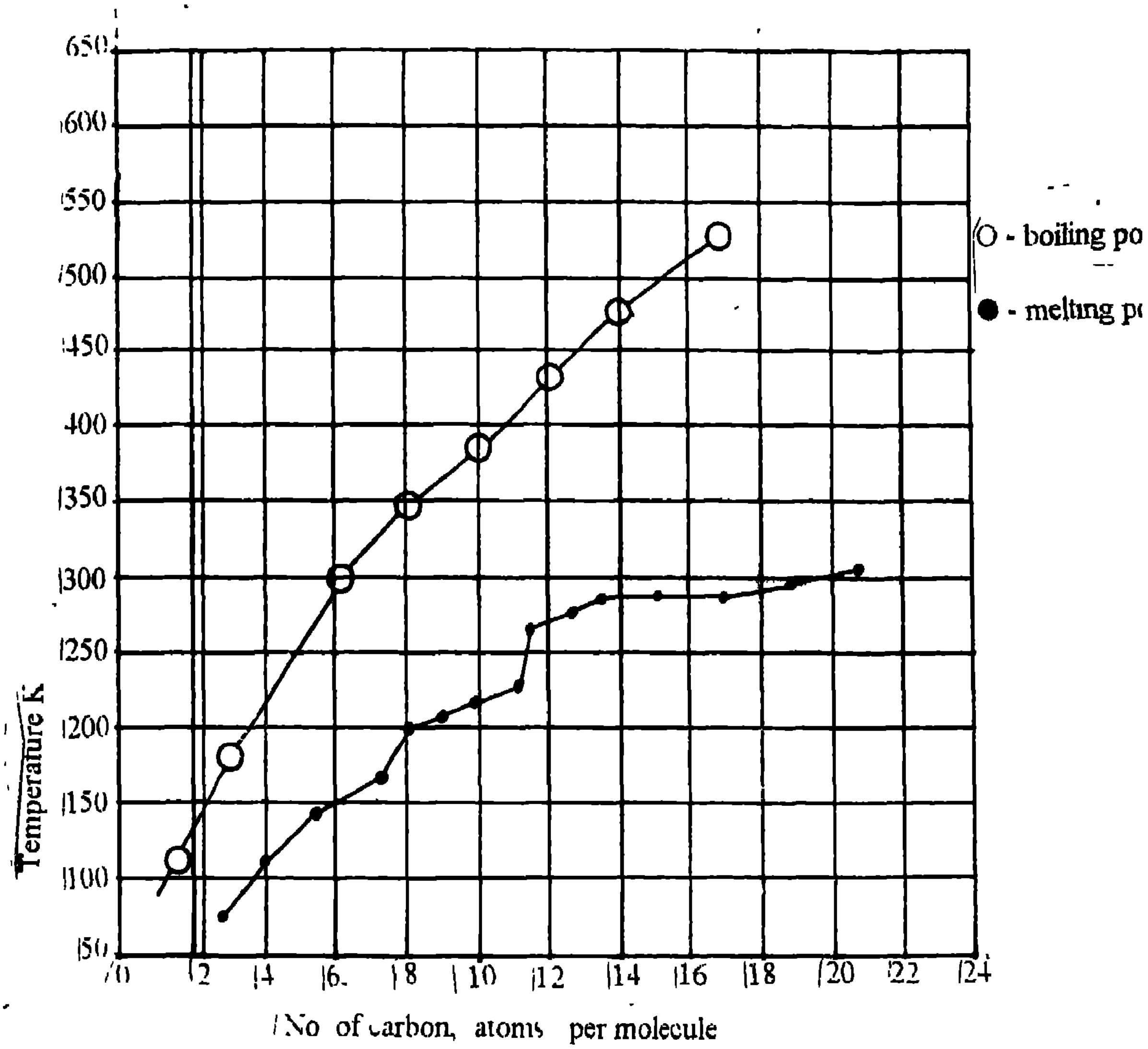


Fig. 8

a) The b.p. plot is almost a straight line, while the m.p. plot has a saw tooth pattern, why ?

b) Why alkanes with odd number of carbon atoms have lower m.p's than those with even number ? Explain.

c) Why alteration in b.p's. like m.p's is not observed with odd and even carbon numbered alkanes.

d) Is the variation in b p's and m p's of alkenes and alkynes the same as in alkanes ?

e) Which type of forces are mainly responsible for molecular - interactions in alkanes ?

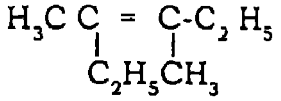
f) Arrange the 3 isomeric alkenes in order of increasing m.p's taking (ii) and (iii) as cis -forms.

$(H_3C)_2C = C(CH_3)_2$ $C_2H_5CH = CHC_2H_5$ $H_5C_2CH = CH\,CH_3$

(i) (ii) (iii)

g) Draw the extended structures of n-pentane and n-hexane showing bond angles between carbons and hydrogens.

h) In case of alkene



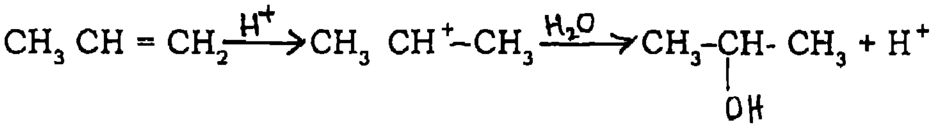
$H_3C\,\underset{C_2H_5}{C} = \underset{CH_3}{C}-C_2H_5$

which isomer will have higher m.p' s.

i) Which of the following pairs of compounds have higher m.p in frozen (solid) state, give reasons

i) benzene and toluene
ii) o-xylene and p-xylene
iii) cis -2- butene and trans-2-butene
iv) o-nitrophenol and p-nitrophenol
v) benzene and phenol.

Q.13. Addition of water to alkenes or hydration of alkenes to form alcohols is usually carried out in the presence of mineral acids as catalyst. The first step of the reaction involves the formation of carbocations Hence the reaction may be called as electrophilic addition reaction.



$$CH_3\,CH = CH_2 \xrightarrow{H^+} CH_3\,CH^+-CH_3 \xrightarrow{H_2O} CH_3-\underset{OH}{CH}-CH_3 + H^+$$

Hydration of two isomeric alkenes of molecular formulae C_5H_{10} yield some alcohol.

a) Write the structures and IUPAC names of the isomeric alkenes.
b) Name and identify the alcohol, obtained on hydration
c) Which carbocation is involved in the reactions.
d) Write the mechanism of the reactions.

Q.14. Simple laboratory tests are applied for distinguishing between differen functional groups in organic compounds Describe the test employe for differentiating between following pairs of compounds.

a) 2-pentyne and n-pentane
b) 1-pentyne and 2-pentene
c) 1-pentyne and 2-pentyne
d) 1,3-pentadiene and n-pentane
e) 1,3 pentadiene and 1- pentyne

Q.15. An organic reaction can be a

i) Substitution e.g. $C_2H_5Br \xrightarrow{KOH} C_2H_5OH$
ii) Elimination e.g. $C_2H_5OH \xrightarrow{\Delta} H_2C = CH_2$
iii) Addition

$$H_2C = CH_2 \xrightarrow{H_2O/H^+} H_3C\ CH_2\ OH$$

Consider the following reaction:

$$C_2H_5OH + C_2H_5OH \xrightarrow{H^+} C_2H_5\text{-}O-C_2H_5 + H_2O$$

a) Is the above reaction an elimination of substitution reaction ?
b) If substitution, whether nucleophilic or electrophilic.
C) What is the nature of nucleophile/ electrophile involved ?
d) Propose a brief mechanism.

Q.16. A hydrocarbon (A) having molecular formula C_5H_{10} discharges the purple colour of cold dil $KMnO_4$ solution and forms another compound (B) which can under go oxidation with periodic acid. The hydrocarbon (A) also adds one mole of Cl_2 to form a compound (c) which on treatment with hot alcoholic KOH gives (D), which on ozonolysis gives, besides another product (E) two moles of methanol.

a) Identify, A,B,C,D,E and write their IUPAC names.
b) Give the products of oxidation of (B) periodic acid.
c) Give logical explanations and write all the reactions.

Q.17. A primary alkyl bromide C_4H_9Br (A), was reacted with hot alcoholic KOH to give a compound 'B' When 'B' was reacted with HBr an isomer 'C' of 'A' was obtained. When a was reacted with sodium, a new compound D (C_8H_{18}) was obtained. The compound 'D' was found to be different from the compound 'E' produced when n-butylbromide was reacted with

sodium.

a) What Name is given to the reaction of A with sodium ?

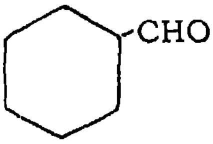
b) What is the product if A is treated with aq alkali instead of hot alcoholic KOH ? What types of reactions are these two ?

c) Write all reactions and identify 'A','B','C','D' and 'E'.

d) Write IUPAC and common names of 'A','B',and 'C'.

Q.18. The following compounds were isolated from the ozonolysis of a hydrocarbon.

i)



(ii) $CH_3COCH_2CH_3$

a) Write IUPAC names of (i) and (ii)

b) Write common name of (ii)

c) Draw the structure and write the name of the hydrocarbon.

Q.19. Boiling points of 1-hexene (64°C) and 1-hexyne (71°C) are sufficiently close so it is difficult to achieve clean separation by distillation.

a) Why the boiling points of the above compounds so close to each other ?

b) Suggest a chemical reaction that might be utilized to remove the last traces of 1-hexyne from a sample of 1-hexene.

c) Write the reactions involved.

Q.20. Isobutylene forms a deliquescent white solid when dissolved in 63% H_2SO_4. If the reaction mixture is diluted with water and heated, an organic liquid (b p 63°C) is formed.

a) Write IUPAC name of isolutylene.

b) What could be the white solid ? Write its structure and name it.

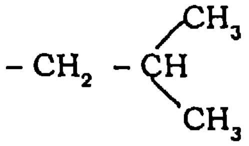
c) What may be the organic liquid b.p 63°C ?

d) Write the reactions involved.

Q 21. When a hydrogen atom is removed from the alkane, the residue is known as alkyl group. Alkyl groups from butane are listed below as an example;

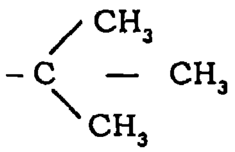
i) n-butyl $-CH_2-CH_2-CH_2-CH_3$ 1°pri

ii) iso-butyl



$-CH_2-CH(CH_3)_2$ 1°pri

iii) tert-butyl



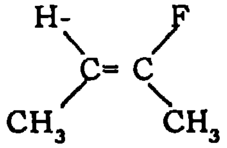
$-C(CH_3)_3$ 3°tert

iv) Sec-butyl $H_3C-\underset{|}{C}H-CH_2-CH_3$ 2° sec.

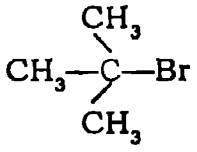
There are eight different five carbon (pentyl) alkyl groups :

a) Draw their structures.
b) Give their systematic names.
c) For each one indicate whether these are 1°,2°,or 3°.

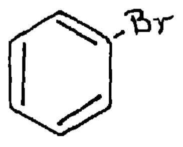
Q.22. Consider the following structures of some molecules;



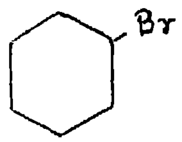
(i)



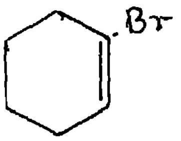
(ii)



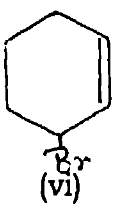
(iii)



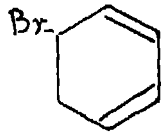
(iv)



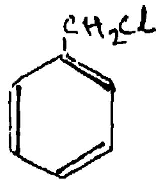
(v)



(vi)



(vii)



(viii)

a) Give IUPAC names of compounds (i), (v), (vi) and (vii)
b) Give common names of (ii) (iii) and (viii).
c) Halogen substituted alkanes are known as alkyl halides. However, depending upon the nature of carbon to which the halogen is

attached, they may get special names e.g. alkyl, allyl, vinyl halides. Classify the above compounds as alkyl, aryl, vinyl, allyl and cyclo alkyl halides.

Q.23 Compounds having generic formula C_nH_{2n+2} exhibit hybridization.

a) What type of hybridization is involved in this series.
b) Write the structural formulae of members of this series containing five carbon atoms and give their IUPAC names.
c) Which of the above compounds (in step b) will have a shape of a perfect tetrahedron
d) Draw the shape of CCl_4 molecule.
e) Name the aliphatic hydrocarbon series represented by the generic formula C_nH_{2n+2}

Q.24. On the basis of elemental analysis and molecular mass determination, the molecular formula of the compound was found to be C_4H_8.

a) How many structural isomers are possible for the above compound.
b) Give the structural formulae and IUPAC names of all the isomers.
c) Which of these isomers show geometrical isomerism ?
Draw structures of geometrical isomer.
d) Mark the isomers under (c) as 'E' or 'Z'.
e) What is the necessary conditions for geometrical isomerism ?

Q.25. An acid of the formula $C_4H_40_4$ has two sterioisomers ('A' and 'B'). 'A' on controlled oxidation with alkaline $KMn0_4$ at low temperature gives an acid (C) which is optically inactive, while 'B' gives two optically active acids.

a) What are the compounds 'A' and 'B' ? Write their structures and name them.
b) One of the two compounds has a zero dipole moment, explain.
c) Write the reactions given above.
d) What is the name of acid 'C' ?

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e) Why acid 'C' is optically inactive ?

f) Can the two optically active acids obtained from 'B' be separated from each other. What is this method of separation known as ?

g) One of the two 'A' or 'B' on treatment with acetyl chloride forms an anhydride, explain.

Q.26. Some organic compounds having active hydrogen in their structures e.g. >C-OH type can react with sodium and undergo easy oxidation, while the >C-O-C< linkage cleaves only under drastic conditions. All compounds having CH_3CO- function, give iodoform test.

a) Write structural formulae of all possible isomers of the molecular formula C_3H_8O.

b) What is the linkage $-\overset{|}{\underset{|}{C}}-O-\overset{|}{\underset{|}{C}}-$ known as ?

c) One isomer 'A' of C_3H_8O is inert to sodium and when heated with excess of HI yields a mixture of methyl and ethyl iodide. Give structural formula of this isomer.

d) One of the isomers 'B' of C_3H_8O on oxidation with pot-assium dichromate and conc H_2SO_4 gave a compound 'C' which gave iodoform test. Identify the isomer and compound 'C'. Write the reactions.

e) Ethanol gives iodoform test although it does not have $CH_3-\underset{|}{C}=O$ function. Explain in brief.

f) Write IUPAC names of 'A','B' and 'C' ?

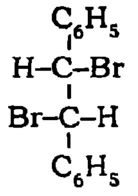
Q.27. Identify the following isomeric pairs .

a) Are they enantiomers diastereoisomers geometrical isomers or identical ?

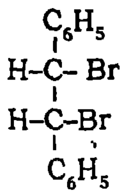
b) Which members are optically active ?

c) What are the conditions necessary for optical activity ?

i)

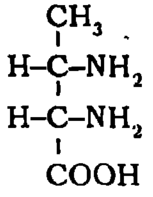


(I)

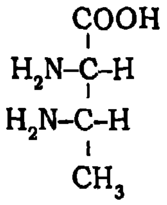


(II)

ii)

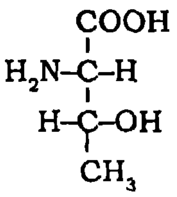


(I)

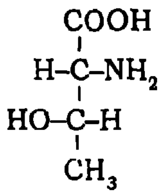


(II)

iii)

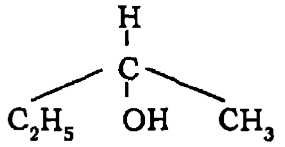


(I)



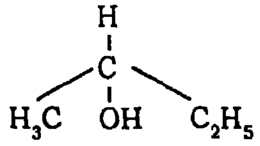
(II)

iv)



d 2 butanol

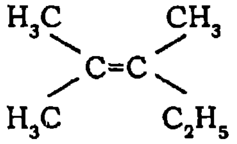
(I)



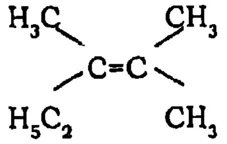
l 2 butanol

(II)

v)



(I)



(II)

vi) l quinine *d* tartrate (I), l quinine l tartrate (II),

Q.28. Fats, waxes and phospholipids are esters and get hydrolysed by heating with alkalies.

a) What products are formed from alkaline hydrolysis of fats and waxes ?

b) Which other specific products are formed from alkaline hydrolysis of phospholipid ?

c) What kinds of sessile bonds are present in these compounds ?

d) What are soaps and spent lye or sweet lye ?

Q.29 Lactose is a disaccharide in which the two monosaccharides are joined by a glycosidic linkage.

a) What are the monosaccharide units of lactose ?

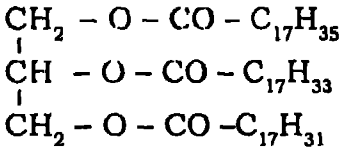
b) Write down the ring structures of the two monosaccharides.

c) How is lactose hydrolysed ?

d) Is lactose the glucoside of galactose
or the galactoside of glucose ?

e) State whether the glycosidic linkage in lactose is α or β.

Q.30. A natural triglyceride has the following structure.



$$\begin{array}{l} CH_2 - O - CO - C_{17}H_{35} \\ | \\ CH - O - CO - C_{17}H_{33} \\ | \\ CH_2 - O - CO - C_{17}H_{31} \end{array}$$

a) What are the products of hydrolysis of the triglyceride ?

b) Give their names and structures.

c) Which one of the hydrolysis products shows geometrical isomerism ?

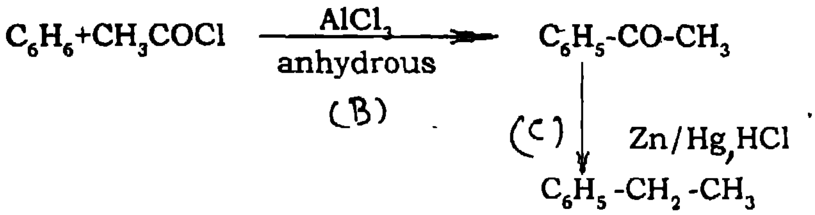
d) What are the structures of the products obtained or reductive ozonolysis of the product mentioned under (c) ?

Q.31. Ethyl benzene can be obtained by one of the following routes :

i) $C_6H_6 + C_2H_5Cl \xrightarrow[\text{anhydrous}]{AlCl_3} C_6H_5\text{-}C_2H_5$

(A)

ii)



$$\begin{tikzcd} C_6H_6 + CH_3COCl \arrow[r, "AlCl_3", "\text{anhydrous}"'] \arrow[r, phantom, shift right=3ex, "(B)"] & C_6H_5\text{-CO-}CH_3 \arrow[d, "Zn/Hg, HCl", "(C)"'] \\ & C_6H_5\text{-}CH_2\text{-}CH_3 \end{tikzcd}$$

a) Which of the two routes is better and why ?

b) What are the names of the reactions mentioned above ?

c) Write down the mechanism of alklation and acylation reactions used in the above example.

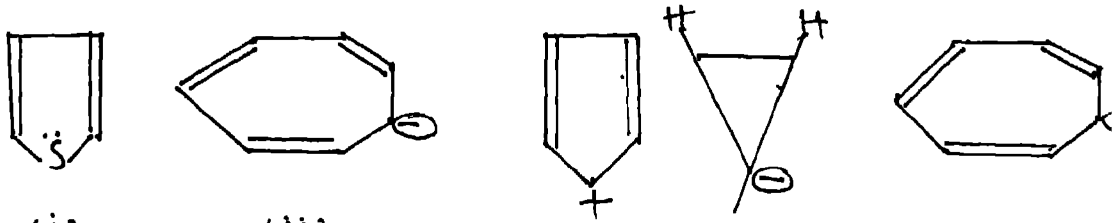
Q.32. Free-radical addition of styrene is used to make polystyrene

a) Give experimental conditions for polymerisation of styrene.

b) Give the mechanism of free radical polymerization of styrene

Q.33. Cyclo-octatetraene (C_8H_8) unlike benzene is not aromatic, it decolourizes both dil $KMnO_4$ (aq) and Br_2 is CCl_4.

Study the structures of the following compounds (i) to (v)



(i) (ii) (iii) (iv) (v)

Fig .9

a) Use the Huckel rule to account for the differences in chemical properties us of cyclo-octatetraene from those of beneze.

b) Is cyclo-octatetraene planar or nonlanar ? Draw its structure.

c) State, whether the above planar species (i) to (iv) are aromatic or nonaromatic.

Q.34. A dibasic acid (X) gave following results on combustion. 0.378 g of the substance gave 0.264g of carbon dioxide and 0.162g water. 0.105g of the acid required 25mL of N/15 NaOH solution for complete neutralization.

a) What is the molecular formula of the compound 'X' ? Write its structure.

b) Give the IUPAC name of the compound 'X'.

c) What products will be formed when 'X' is heated with glycerol at different temperatures ?

Q.35. A volatile organic compound 'Z' contained 10% C, 0.84% H and89.12% Cl. In victor Meyer's method for the determination of molecular weight, 0.6 g of the substance displaces 112 mL of air at S.T.P.

a) What is the compound 'Z' ?

b) Will this compound react with n-butylamine in presence of KOH ? If yes give the reaction involved.

c) What products are obtained when 'Z' reacts with phenol in presence of alkali ?

Q.36. A hydrocarbon C_6H_{12} decolourizes bromine water and alkaline solution of $KMnO_4$. It dissolves in conc H_2SO_4 and produces hexane when reduced. The hydrocarbon when oxidized with acidic $KMnO_4$ produces butyric acid and acetic acid.

a) Write the structural formula of the hydrocarbon and give its IUPAC name.

b) Give the equations of the reactions in which hydrocarbon gives with the reagents mentioned above.

c) What products will be formed on ozonolysis of the hydrocarbon ?

Q.37. The molecular formula C_5H_8 represents three isomeric alkynes.

a) Write the structural formulae for each isomer giving IUPAC names.

b) Two of these alkynes react with ammoniacal $AgNO_3$ and ammoniacal cuprous chloride. How will you distinguish between these two alkynes ?

c) Why the third alkyne does not react with reagents? mentioned in b ?

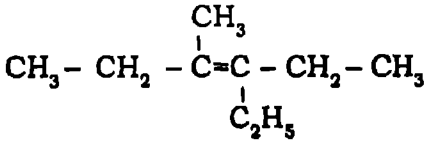
Q.38. A hydrocarbon (V.D.27) containing C=88.88% decolourized $KMnO_4$ solution and bromine without evolving HBr. It does not give precipitate with either ammoniacal silver nitrate or cuprous chloride solution. On reaction with dil H_2SO_4 in presence of mercuric sulphate, it gives ethyl methyl ketone.

a) What are the empirical and molecular formulae of the hydrocarbon ?

b) What are possible structural formulae of the hydrocarbon ?

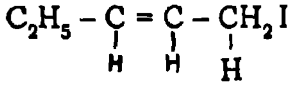
c) Which of the structures given under (b) is the correct structure and why ?

Q.39. Study the following alkenes :

i) 

$$CH_3-CH_2-\overset{\overset{CH_3}{|}}{C}=\underset{\underset{C_2H_5}{|}}{C}-CH_2-CH_3$$

ii) $CH_2=C(Cl)-CH_3$

iii) 

$$C_2H_5-\underset{\underset{H}{|}}{C}=\underset{\underset{H}{|}}{C}-\underset{\underset{H}{|}}{CH_2I}$$

iv) $CH_3-CH=CH-CH=CH-CH_2-CH_3$

v) $CH_3-CH=CH\text{-}CH=CH_2$

vi) $CH_3-CH=CH\text{-}CH=CH-CH_3$

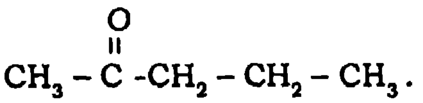
a) Which of the above alkenes exhibits geometrical isomerism.

b) Which of the above alkenes do not exhibit geometrical isomerism and why ?

c) Give structural formulae and names of the isomers.

Q.40. We can locate the position of double bond in an alkene by ozonolysis. Deduce the structures of the following alkenes.

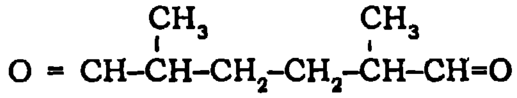
a) An alkene $C_{10}H_{20}$ on ozonolysis yields only



$CH_3-\overset{\overset{O}{\|}}{C}-CH_2-CH_2-CH_3$.

b) An alkene C_9H_{18} on ozonolysis gives $(CH_3)_3-C-CHO$ and $CH_3-CO-CH_2-CH_3$.

c) A compound C_8H_{14} adds one mole of H_2 and forms on ozonolysis the dialdehyde.



$O=CH-\overset{\overset{CH_3}{|}}{C}H-CH_2-CH_2-\overset{\overset{CH_3}{|}}{C}H-CH=O$

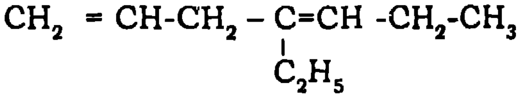
d) An alkene C_8H_{12} adds two moles of H_2 and gives on ozonolysis only one dialdehyede $OCH-(CH_2)_2-CHO$.

Q.41. In dehydrohalogenation the preferential order for removal of H atom is 3° > 2° > 1° (Sayzeff rule) we can say 'the poor get poorer". What products would be formed predominantly on dehydrobromination of :

a) 1- Bromobutane
b) 2- Bromobutane
c) 3-Bromopentane
d) 2-Bromo-2-methylpentane
e) 3 -Bromo-2-methylpentane.
f) 3-Bromo-2, 3-methylpentane.

Q.42. Study the following alkadienes :

i) $CH_2=CH-CH=CH-CH_3$

ii) 

$CH_2=CH-CH_2-\underset{\underset{C_2H_5}{|}}{C}=CH-CH_2-CH_3$

iii) $CH_2=C=CH_2$

iv) $CH_2=CH-CH=CH-CH=CH_2$

(Hint : An alkadiene contains two double bonds).

a) Give IUPAC names of the above alkadienes.

b) Classify them as cummulated, conjugated or isolated double bonds.

Q.43. Mention the reagents and reactions needed for following conversions.

a) Acetylene to ethylidene iodide.
b) Propyne to isopropyl bromide.
c) 2-Butyne to racemic 2,3 -dibromobutane.
d) 2-Bromobutane to trans-2-butene.
e) n-Propyl bromide to 2-Hexyne.
f) 1-Pentene to 2-pentyne.

Q.44. Hexadiene (C_6H_{10}) can be expressed as eleven isomeric compounds.

a) Give the structural formulae of all the isomeric compounds.
b) Give IUPAC names of the isomers.
c) Write down the possible geometrical isomers for each of the eleven isomers.

Q.45. An alkene 'A' gives the following reactions :

i) On catalytic reduction yields 2-methyl butane.
ii) It adds HBr to form compound 'B'.
iii) 'B' an mild alkaline hydrolysis yields alcohol 'C'.
iv) Alcohol 'C' on oxidation gives a Ketone containing the same number of carbon atoms.
a) Based on reaction (i) deduce the structures of possible isomers of 'A'
b) Write down the possible structures for compound 'B' based on reaction (ii)
c) Write down the possible structures of alcohol 'C' based on reaction (iii).
d) How reaction (iii) helps in deducing the correct structure of the alkene ? Explain.

Q.46. A compound of the formula $C_4H_{10}O_4$ yields on acetylation a derivative having formula $C_{12}H_{18}O_8$.

a) How many hydroxyl groups are present in the compound ?

b) Write the structure of the compound.

c) How many stereoisomers are possible for $C_4H_{10}O_4$?

Q.47. An organic compound 'A' on analysis was found to contain C=39.13% and H=8.64% and its molecular weight was found to be 92. It gives a triacetate with acetic anhydride.

a) What is the molecular formula of compound 'A' ?

b) Write down the structure of Compound 'A' ?

c) What products would be formed when 'A' reacts with :

(i) P_2O_5 (ii) Conc HNO_3 + fuming H_2SO_4 and (iii) PI_3 in excess.

Q.48. On elemental analysis a gaseous hydrocarbon with vapour density 20, was found to contain 89.93% carbon and 10.1% of hydrogen by weight.

a) Find out the empirical formula of the compound.

b) Calculate its molecular formula.

c) What is the generic formula of the compound ?

d) How many isomers are possible for the compound ?

e) Write down the structural formulae of all the isomers. Which of the isomer has an acidic hydrogen ?

Q.49. A hydrocarbon (molecular mass 84 amu) on elemental analysis was found to contain 85.7% carbon.

a) What will be the empirical and molecular formulae of the compound.

b) Write down the generic formula of the compound ?

c) Write down the structural formulae of all the acyclic isomers.

d) Which of the compounds listed in 'c', will show geometrical isomerism and optical isomerism ?

Q.50. Potential energy vs. rotational energy curve for different conformations of butane are as follows :

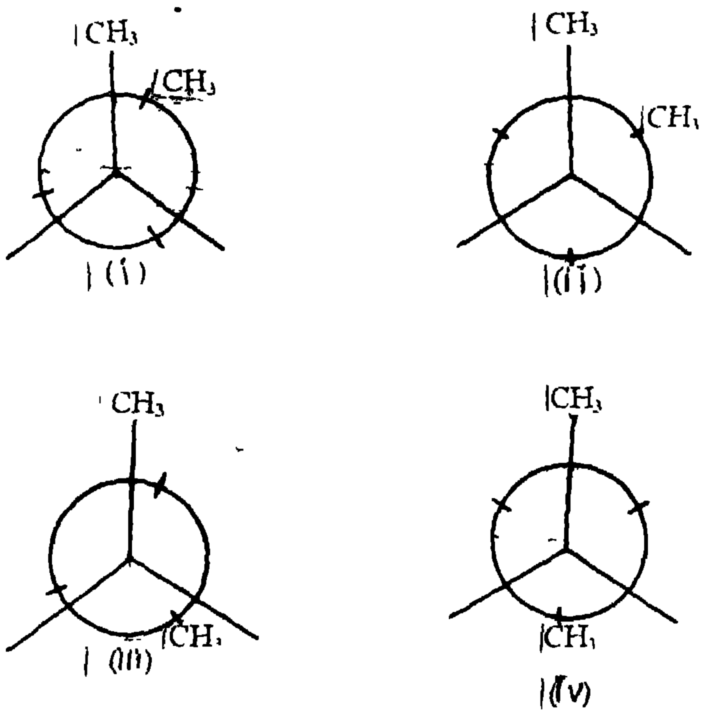


Fig. 10

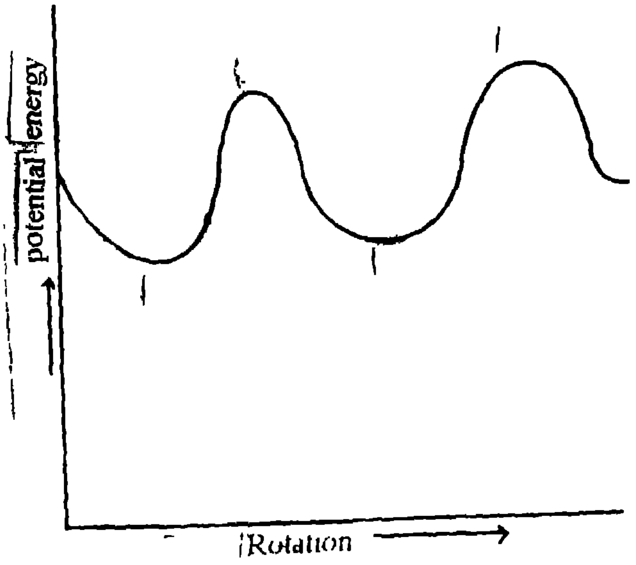


Fig. 11

a) Conformers of hydrocarbon are usually represented either by sawhorse projection or the Newman projection. Which to these two is the one used to represent i, ii, iii and iv conformers ?

b) Draw these conformers through sawhorse projection.

c) Which of the above are the eclipsed and which are the staggered conformations ?

d) Arrange these conformers in order of increasing stability.

e) Match the conformations i, ii, iii and iv with the corresponding peaks/troughs in the given diagram (Fig. 11) and mark accordingly.

Q.51. A hydrocarbon with molecular formula C_7H_{12} containing a triple covalent bond exists in eleven isomeric forms.

a) Draw structural formulae of all the isomers and write down IUPAC names of the above.

b) Indicate which of the isomers will react with Ag^+ and Why ?

Q.52. An organic compound 'A' having molecular formula C_3H_7Br when treated with alcoholic KOH gives a compound 'B' but with aqueous KOH gives another compound 'C'. Compound 'B' when treated with hydrogen bromide gives 'D', an isomer of 'A' but on hydrolysis it gives 'E', an isomer of 'C'. The compounds 'C'and 'E' both on dehydration give 'B'.

a) Give schematic representation of the above reactions.

b) Write IUPAC names of the compounds 'A' to 'E'.

c) How can you get back compound 'A' from the compound 'B' ?

d) What type of isomers are 'A' and 'D' as well as 'C' and 'E' ?

e) What type of reactions are taking place during the conversion of 'A' to 'B' and 'A' to 'C' ?

Q.53. On the basis of elemental analysis and molecular mass determination the molecular formula of the compound was found to be C_8H_{16}. It gives butanal as one of the products on ozonolysis.

a) How many isomers (excluding stereoisomers) are possible for the compound. Give their structural formulae and IUPAC names.

b) Which of the above isomers will react with hydrogen bromide in the presence as well as in the absence of peroxide to give the

same product ?

Q.54. Elemental analysis and molecular mass determination elucidate the molecular formula of a hydrocarbon as C_7H_{16}..

a) Draw all possible chain isomers for the compound, and give their IUPAC names.

b) Which isomer has the lowest and which one has the highest boiling point.

Q.55. A noncyclic hydrocarbon has molecular formula C_5H_{10}.

a) Write structures for possible isomers of this compound and give their IUPAC names.

b) which of the above isomers when treated with concentrated $KMnO_4$ solution will give propanoic and ethanoic acids ?

c) Which isomer on treatment with concentrated $KMnO_4$ solution will give 2 -methyl propanoic acid and carbon dioxide ?

d) Identify the isomer which will give butanoic acid and carbon dioxide when treated with concentrated solution of $KMnO_4$?

e) Which isomer will give butanone and carbon dioxide when treated with concentrated $KMnO_4$ solution ?

Q.56. Cycloalkanes in which the tetrahedral value ($109^\circ 28'$) of carbon bond angles is retained are inert like non-cyclic alkanes.

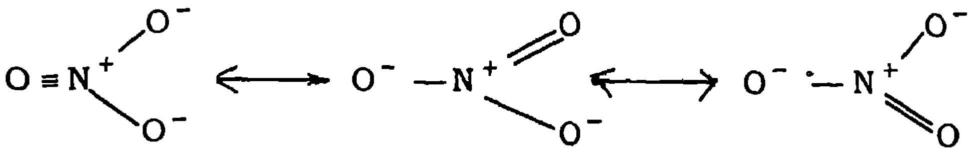
a) How many conformations are there for cyclohexane ?

b) Arrange these conformers in order of increasing energy.

c) Amongst cyclobutane, cyclopentane and cyclohexane which one is most stable and why ?

d) Amongst the three cycloalkanes given under 'c' which one is least stable ?

Q.57. The nitrate ion is stabilised by resonance as follows :



a) Draw resonance structure if any, for H_2CO_3 and HCO_3 and state which of the above two will be more stable ? why ?

b) Draw resonance structures if any, for $H_2SO_4^-$, HSO_4^- and SO_3^{2-}.

Questions
on
Inorganic Chemistry
(Class-XI)

Q.1. The following diagram (Fig.12)for formation of an oxide, describes the thermodynamics of metallurgical operation during the oxidation and also the reduction process for a sponteneous reaction of the type :

$$\Delta G = \Delta H - T \Delta S$$

Study the thermodynamic behaviour of the metallurgical operations with the help of Fig.12 given below

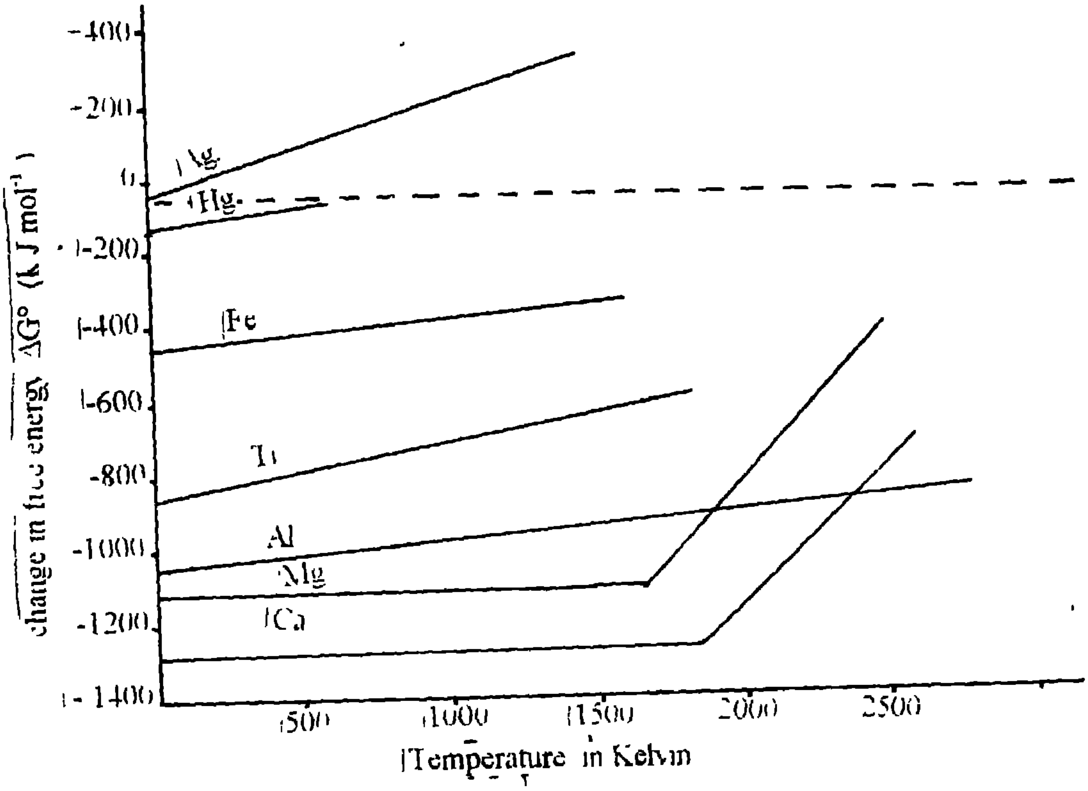


Fig. 12

a) State the relationship of the free energy with temperature.

b) Interpret the fact that all slopes are upward.

c) State the reason for the change of the slope in the line in case of Hg and Mg.

d) What will happen to the oxide if the temperature of the reaction is raised to such an extent that it crosses the horizontal dotted line ?

e) From the perusal of the Fig.12 given above name two elements which can be extracted by thermal decomposition from their oxides. Why is it not possible to apply this technique to all oxides.

f) Explain, giving reason in terms of free energy, why does aluminium

reduces FeO but it does not reduces MgO ?

Q.2. The melting points and boiling points of the five halides of carbon are shown below in the graph.

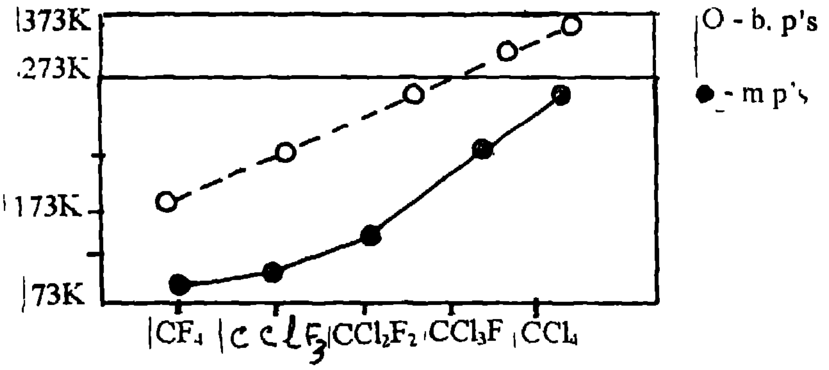


Fig.13

a) Draw the electron dot structures of $CClF_3$ and CCl_2F_2.

b) Which of the five compounds shown in the Fig.13 have dipole moment ?

c) In the Fig.13 above the boiling points show a linear increase while the melting points show a pronounced deviation from linearity. Explain with reason.

d) Which of the halides are potent air pollutants ?

e) State a cause that makes a carbon halide, a potential air pollutant.

f) State one use of any one of the mixed halide of carbon.

Q.3. Over a along period of time the gaseous Nebula Cooled and ultimately the Earth's Crust was formed. The Igneous Rocks were thus formed following the natural rules of fractional crystallization and preferential packing based on certain characteristics of elements. Similarly wheathering is selective in extraction using certain natural forces acting as eroding agents and thus we see the accumulation of certain substances at their present location All these elements and compounds may not remain where they are today.

a) Name the type of locations where Na, K and Mg ions are likely to

be found in large amounts.

b) Why is sea water salty ?

c) Name 10 elements found in human body.

d) What is the role of Nitrogen, potassium and phosphorous in plants ?

e) How does weathering affect the nitrogen cycle and carbon cycle in nature ?

f) How does sea weeds get enriched with Iodine ?

Q.4. a black sulphide ore was roasted to give pure metallic oxide 'A' and a gas 'B'. The gas is oxidized in the presence of a catalyst 'C' to give a higher oxide 'D' of the same element. The compound 'D' is dissolved in Tetraoxosulphate (vi) acid to give another compound 'E'.

Oxide 'A' is reduced to the metal 'F' when heated with the purified ore. The impure metal 'F' is purified by elecrolytic reduction to give the pure metal.

a) Idnetify 'A','B','C','D','E',and 'F'.

b) Write the reaction showing the conversion of 'D' to 'E'. and the reaction of 'A' to give 'F'.

c) Name the material of which the cathode is made of in the electrolytic reduction.

d) Write the reacton occuring at anode.

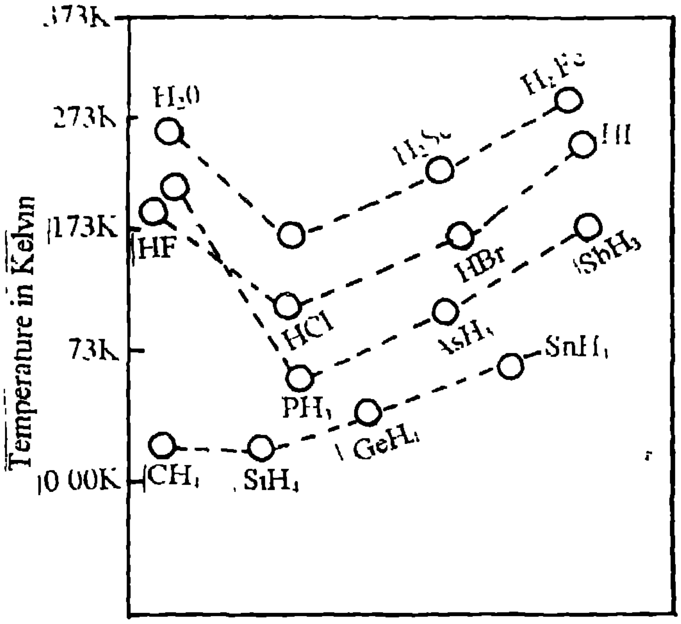
e) Write the reaction showing the hydrolysis of compound 'E'.

f) Write a half reaction involved in the process that shows the reduction of a compound to the metal and another half reaction showing oxidation of the metal.

g) Name atleast two metals that are likely to be found in anode mud.

h) Name one source of the metallic element found in catalyst 'C'.

Q.5. Study the graph given below.



Melting points of hydrates of IV, V. VI and VII group elements

Fig.14

a) Give the reason for the abnormally high m.p. of NH_3 as compared to other hydrides of the same group.

b) CH_4, NH_3, H_2O and HF are the first member hydrides of group IV,V,VI and VII respectively. Give reasons for their differences in respect of the following :

i) methane has a regular tetrahedral structure where as other hydrides have distorted tetrahydral structures.

ii) Methane has uniform melting point as compared to other family members and these hydrides show deviation in their melting points.

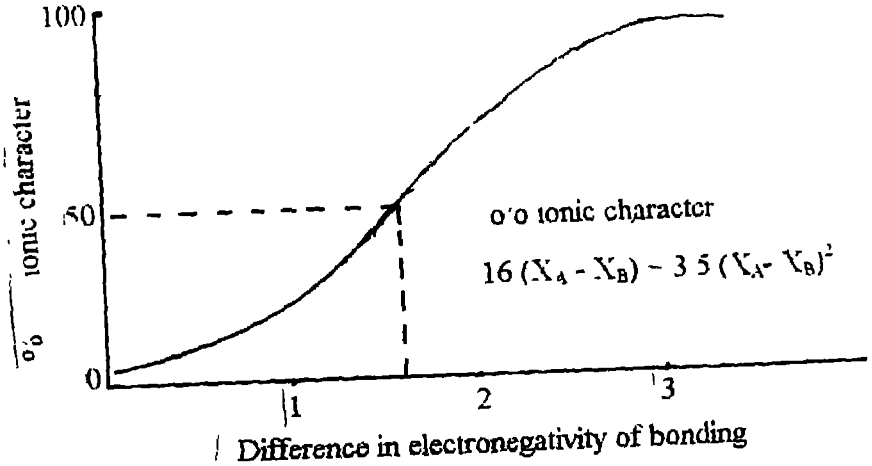
iii) Which of these Hydrides is likely to be polymeric ?

iv) Which of these Hydrides can show dipole moment.?

c) i) Arrange the hydrides of group-IV in decreasing order of their thermal stability.

ii) What is the reason for (i) above .?

Q.6. Study the Fig.15 given below and the the periodic table.



(Fig. 15)

a) Select two elements that make a compound more soluble in water than Cs_2O. Name the compound.

b) Name a halide of zinc that is less soluble in water than zinc bromide.

c) Find out the approximate % ionic character of LiCl from the group (given electronegativety of Li=1.0; Cl=3.0 and that of Na=0.9 in NaCl.)

d) Calculate the % ionic character of Cl-Cl bond in Cl_2.

e) Compare the % ionic character of CuCl and $CuCl_2$ (eletronegativity of cu = 1.9)

f) Give the qualitative estimate of the relationship of electronegativity with standard electrode potential of an element.

g) Name the compound (diatomic) that is most ionic in nature (using the table of electronegativities)

h) What can be the highest value of % ionic charecter. Why it cannot be 100% ?

Q.7. The silver atoms are packed in a face centered cubic arrangements (Fcca) and the unit cell edge is 4.078 A°.
Calculate the density of metallic silver.

Q.8. Hydrogen molecule consists of two hydrogen atoms, each atom having one proton in its nucleus with an electron moving around it. Both the electrons and protons (nucleus) posses the property of spin about an axis.

a) When electrons in ordinary hydrogen atoms, have same spin, is the formation of hydrogen molecule possible ?

b) What is the specific name of hydrogen molecule where the protons (nucleou) have same spins.

c) Give the specific name to the hydrogen molecule, where protons have opposite spins.

d) Write down the magnetic moment of ortho form of hydrogen molecule.

e) What will be the value of magnetic moment of para form of hydrogen molecule.

Q.9. Sulphur needs two electrons for completing its octet. It completes its octet by forming a single covalent bond with two other atoms of sulphur. In this way either a ring (S_8) or long chain configuration is obtained. In long chain configuration the two end atoms have abnormal structure. When molten sulphur is heated to a temperature above to its melting point, it becomes deep red in colour as well as it appears extremely viscous. Explain the following questions on the basis of aforesaid content.

a) What structural change takes place in the formation of deep red colour ?

b) What structural change occur in the formation a highly viscous materials ?

Q.10. The graph given below shows the energy (kJ/mol) and distance between muclei (A) of hydrogen molecule.

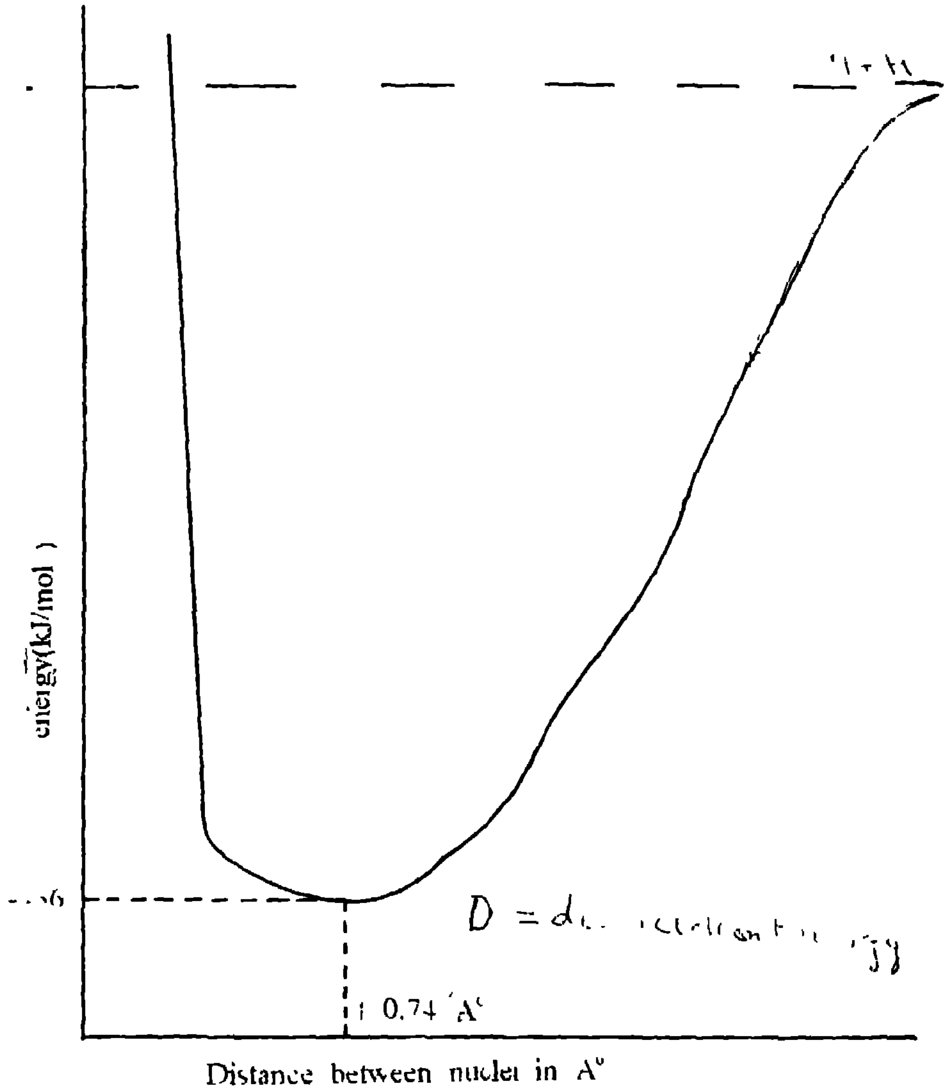


Fig.16

a) What is the bond length of hydrogen molecule as is evident from the graph.

b) Is repulsive force between two electrons and between two nuclei same ?

   (i) If yes, Explain why ?

   (ii) If No, Explain Why ?

c) What is the minimum bond energy of hydrogen molecule as per graph ?

Q.11. Group-VI A elements in general and non-metals of the group in particular, forms many ores, oxides and sulphides of the metals. About

half of the earth's crust is made of the aforesaid group of elements.

a) Why oxygen molecule is a gas while sulphur is a solid ?

b) Explain, why oxygen molecules have the formula O_2 while sulphur is S_8 ?

c) Why is the hydride of oxygen a liquid while hydride of sulphur is gas.

Q.12. **Step-I**

Concentrated nitric acid, obtained by distilling the acid until it boils at constant temperature, has a density of 1.42 g/mL and it contains about 68% HNO_3 .

a) Calculate the molarity of the acid.

Step-II

An inorganic compound 'A' is obtained by heating a mixture of compound 'B' and coke. 'A' when heated with nitrogen to 1000°C in an electric furance gives compound 'C' alongwith carbon as a by product. Compound 'C' can be hydrolysed to give compound 'D' alongwith the by product 'E'. Compound 'D' is a good solvent in the liquied state. 'D' gives white fumes with a glass rod dipped in conc HCl. Compound 'D' dissolves in water to give a solution which turns red litmus blue. 'D' gives complex ions with the metal ions Ag^+ and Cu^{2+} . 'D' is directly used as a fertilizer. Also compounds of 'D' with nitric acid and sulphuric acid are used as fertilisers. Compound 'B' reacts vigorously with water evolving a lot of heat and the resulting product absorbs carbondioxide to give compound 'E'. Reaction of 'A' with water gives an organic compound of molecular furmula C_2H_2 .

b) Explain the above reactions and identify compounds 'A','B','C','D' and 'E'.

c) Explain a method by which compound 'D' is converted into nitric acid giving details of the reactons involved.

Q.13. **Step-I**

2 g of a sample of ammonium sulphate fertilizer was boiled with excess

of caustic soda solution The ammonia liberated was absorbed in 150 mL of N/2 sulphuric acid. The partially neutralised acid was made upto 250 mL with distilled water in a standard flask. 20mL of the solution of this acid was completely neutralised by 40mL of decinormal solution of sodium hydroxide.

a) Calculate the precentage purity of the ammonium sulphate fertilizer sample.

Step-II

Ammonium sulphate, ammonium chloride, ammonium nitrate and urea are examples of nitrogenous fertilizers.

b) Out of the four nitrogenous fertilizers mentioned above which one supplies highest percentage of nitrogen to the soil ?

c) Ammonium nitrate is not used directly as a fertilizer why ? In which combined form it is used as a fertilizers ?

Step-III

Nitrogen is prepared in the laboratory by heating gently a mixture of solutions of sodium nitrate and ammonium chloride.

d) Explain the change in the oxidation states of nitrogen and indicate the type of reaction taking place.

e) Why is solid ammonium nitrate not heated directly ?

f) Give the precaution prescribed for this reaction ?

Q.14 **Step-I**

3g of a sample of limestone was dissolved in 15mL of 2 N hydrochloric acid and the solution made up with distilled water to 100 mL in a standard flask. 20 mL of this solution required 15mL of 0.1N sodium hydroxide solution for complete neutralisation.

a) Calculate the percentage of calcium carbonate in the limestone sample.

Step-II

A mixture of conc HNO_3 and conc H_2SO_4 is extremely useful

b) What is the name of this mixture of acids ?

c) How is this acid mixture used ? Cite an example.

d) Name the species which is responsible in bringing about the reaction.

Step-III

A mixture of conc HNO_3 and conc HCl is extremely useful to dissolve metals such as gold, platinum.

e) What is the name assigned to this acid mixture ?

f) Write the equation and illustrate why gold is soluble in this acid mixture ?

Q.15. **Step-I**

Commercial conc H_2SO_4 is a colourless thick syrupy liquid corresponding to a normality of about 36 N.

(Hint ; Density of conc H_2SO_4 is 1.84 g /mL and purity 98.3%).

a) How is this value of normality arrived at ?

Step-II

The undermentioned elements are found in the third row of the periodic table

Na Mg Al Si P S Cl Ar

b) Which of these form positive ion ?

c) Which elements form negative ions ?

d) Which of these elements do not form compounds ? Why ?

e) Which of these elements has the highest melting point ? Why ?

f) Which of these elements exist as diatomic molecules ?

g) Which elements form compounds of the general formula 'AB' ?

h) Which elements form chlorides corresponding to the formula XCl_3 and XCl_4 ?

Step-III

Wood is charred by the addition of conc H_2SO_4. So also sugar which turns black on the addition of a few drops of conc H_2SO_4.

i) Which property of conc H_2SO_4 is illustrated in these reactions ?

j) Explain with equation, the reaction that takes place

k) How is conc H_2SO_4 diluted ? What precaution is to be followed in doing this dilution ?

Q.16. **Step-I**

Commercial conc HCl has a density of 1.19 g/mL and it contains about 37% HCl.

a) Calculate the normality of the acid.

Step-II

1.84 g of a mixture of limestone and dolomite was heated with 50 mL of I N hydrochloric acid. The excess acid required 20 mL of N/2 sodium hydroxide for neutralisation.

b) Calculate the percentage of calcium carbonate and magenisum carbonate in the mixture.

Step-III

Suppose the prices of magnesium, aluminium zinc and iron scarp per kg are Rs. 108,92, 72 and 12 respectively.

(Hint : Atomic mass of Al = 27, Mg = 24.3, Fe = 55.8, Zn = 65.4, S = 32.1, 0 = 16, H =1.0)

c) Find out which metal is the cheapest to use for the production of hydrogen gas, by the reaction of the metal with dil H_2SO_4.

Q.17. Some of properties of noble gases such as percentage of particles in air, melting point and boiling point are given in the following table.

Element & symbol.	**% of particles in air.**	**Melting point (°C)**	**Boiling point (°C)**
Helium (He)	0.00052	-	-269
Neon (Ne)	0.0018	-249	-246
Argon (Ar)	0.93	-189	-186
Krypton (Kr)	0.00011	-157	-152
Xenon (Xe)	0.00009	-112	-108
Radon (Rn)	Trace	-71	- 62

a) What is the other name for noble gases ?

b) Why are the melting points and boiling points of rare gases, very low ?

c) Why Helium does not solidify at OK.

d) Why is it that oxygen, chlorine,fluorine exist as diatomic molecules while neon, argon and krypton exist as uncombined atoms ?

e) Would you except the ionisation potential of sodium to be greater or less than the ionisation potential of neon ? Give reason for your answer.

f) Name some xenon compounds that have been made and indicate their methods of preparation.

g) Why are the noble gases very unreactive at room temperature ?

h) Why is Helium used in weather balloons and cryogenics ?

i) Which noble gas is used to create an inert atomsphere ?

j) Which property of noble gas accounts for their use in bulbs ?

k) Name the noble gas used in discharge tubes.

Q.18 A chemist during his investigation finds that water is very stable and does not decomposes by heat even at 2000 °C. It has multifarious roles in reactions. It acts as an oxidiser and reducer in chemical reactions.

Water may be reactant, product or solvent in many reactions.

a) What is the role of water inthe reaction between acids and bases ?
b) Give two example of reactions where water is a product.
c) Give two example of reactions where water is reactant.
d) Write the equation for the reduction of permanganate ions in aqueous solutions by iron (II) ions and explain the role of water in this reaction.
e) What role is played by water in the acid hydrolysis of ethyl acetate. Write the equation and explain ?
f) What are the products of decompositon of water ?
g) What is the simple method of the decomposition of water ?
h) $H_2O\,(l) + e^- \rightarrow \frac{1}{2} H_2(g) + OH^-\,(aq)$

   what does this equation tell you ? Does water act as oxidiser or reducer in this case ?
i) In the reaction with Co (III) ion, will water act as an oxidiser or reducer ? What is the nature of the resulting solution. Name the gas that is evolved in this process and write the equation.

Q.19. An investigator finds that H_2O_2 is a good bleaching agent. It decomposes when kept for longer duration.

a) Why is hydrogen peroxide used as a bleaching agent ? What reaction is responsible for the bleaching action of H_2O_2 ?
b) Write the equation and state whether hydrogen peroxide acts as oxidiser or reducer in the undermentioned reactions.
   i) reaction of H_2O_2 with Cl_2 .
   ii) reaction of H_2O_2 with moist silver oxide.
   iii) reaction of H_2O_2 with $KMnO_4$ in acidic medium.
   iv) reaction between hydrogen peroxide and ozone.
   v) reaction of hydrogen peroxide with lead sulphide.
c) How is H_2O_2 stored in the laboratory ?
d) What products are formed when hydrogen peroxide undergoes

decomposition ?

Q.20. We know that the elements fluorine, chlorine, brmine, iodine are called the Halogens. The halogens are mostly found as the halide ions combined with metal ions. Each of the halogen forms a compound with hydrogen with general formula HX. They are soluble in water to form acidic solutions. Many of the insecticides used in agriculture are chlorine substituted carbon compounds. Chlorofluoro carbons, polymers containing chlorine, polymers containing fluorine, iodised salt find applications in daily life.

a) Why are halogens not found as free elements in nature ?

b) Explain, why is iodine insoluble in water but soluble in potassium iodide solution ?

c) Explain the biological importance of iodine What is iodised salt? What is its importance ?

d) Infer what reaction will occur and write equations for the following
   - i) Chlorine is bubbled into aqueous sodium bromide solution.
   - ii) Bromine water is added to aqueous sodium fluoride solution.
   - iii) Chlorine is bubbled into aqueous sodium iodide solution.
   - iv) Chlorine is bubbled into aqueous sodium fluoride solution.
   - v) Iodine is put into aqueous sodium chloride solution.
   - vi) Iodine is put into aqueous sodium bromide solution.

e) Give the formulae of poly vinyl chloride and polytetrafluoroethylene. What are their uses ?

f) Give the name and structure of two halogen substituted hydrocarbons used as insecticide.

g) calculate the mass of iodine which can be obtained from 16 6 g. of potassium iodide by oxidation with chlorine.

h) What is the chief use of BrH_2C-CH_2Br ?

i) What are environmental problems associated with the insecticides ?

j) Why are fluoride ions of the order of 1ppm added to the drinking water ?

Q.21. We know that phosphorus is one of our most important elements. Phosphate compounds store energy in our bodies Phosphorus compounds find important uses as fertilisers, insecticides, corrosion inhibiter, detergents, in safety matches etc. phosphoric anhydride is an important compound.

a) A mixture of bone, ash sand and coke were heated in an electric furnace. What is the main product of the reaction ? What is the slag so obtained ?

b) What are the various forms in which the main product exist ?

c) How are these forms stored and kept safely in the laboratory ?

d) Name the major component of bones, teeth enamel.

e) What is the reaction taking place in tooth decay ?

f) Give one example of phosphate fertilizer and write its method of preparation.

g) What are corrosion inhibitors ?

h) How is baking powder produced ?

i) What is phosphoric anhydride ? Give equations for the synthesis of the three oxyacids of phosphorus from phosphoric anhydride?

j) How is phosphorus made use of, in producing safety matches

k) discuss the environmental problems associated with phosphates.

Q.22. We know that silicon is the most abundant element in the earth's crust The main forms in which silicon occurs are silica, feldspar, mica, quartz and clay. Silicon finds application in making silicon chips for use in computers, television etc and in making solar cells. A number of other industrially important silicon compounds are also known.

a) Why is silicon regarded as some non-metallic rather than metallic ?

b) Give the composition and use of the undermentioned silicate minerals, Asbestos, mica. garnet, talc kaolin. feldspar. beryl, zeolites.

c) What is granite ? What is its main use ?

d) What is water glass ? How is it obtained ? What is its chief use?

- e) Although talc and feldspar are silicate minerals talc is soft possessing lubricating properties while feldspar is hard, why ?
- f) The present age can be called as 'silicon age' substantiate this statement.
- g) Sketch the outline of the structure of silica ?
- h) What is silica gel ? What is its main use ?
- i) Why are glass containers not suitable for storing concentrated solution of alkalies ? Write the equation for the reaction.
- d) What is fibre glass ? Give its main use.

Q.23. An element with atomic number 11 reacts with oxygen on heating forming oxide as well peroxide. The metal can easily release its electron from the valence shell. It reacts exothermally with water and forms an alkaline soultion. Its chloride is soluble in water and the solution is highly conducting. Its oxide and peroxide are soluble in water producing an alkaline solution.

- a) Indicate the position of element in modern periodic table (s,p or d block) and name the metal.
- b) Will the element be electropositive or electonegative ?
- c) Will the element be a metal or a non-metal ?
- d) Will the element act as a reducing agent or as an oxidising agent ? why ?
- e) Why is the solution of its chloride in water highly conducting ?
- f) Compare the conductivity of its chloride solution in water with the conductivity of chloride solution of element of atomic number 19.
- g) Compare the thermal stability of its chloride with that of the chloride of element of atomic number 19.
- h) Write down the chemical equation showing its reaction with oxygen
- i) Write down the chemical equation showing the reaction of its oxide and peroxide with water.
- j) Will any gas be evolved when it reacts with water ? If so name the gas and write down the chemical equation.
- k) Write down the name and symbol of the element which will be

isoelectronic with monovalent ion of the element

l) Indicate the method for the storage of the element in laboratory. Can the element be placed in air ? If not, why ?

m) Write down separate oxidation and reduction reaction leading to the formation of Na_2O.

Q.24. Sodium (mp= 370.8K) is a strong elecropositive metal. It reacts exothermally with water and forms an alkaline solution. It is obtained by the electolysis of a molten eutectic mixture consisting sodium chloride (40%) and calcium chloride (60%) at 850 K in an electrolytic cell consisting of a carbon (graphite) anode and an iron (steel) cathode. On electrolysis sodium metal is formed at cathode. Standard reduction potentials for Na^+ and ca^{2+} are -2.714 volt and -2.866 volts respectively.

a) Can sodium metal be obtained by the electrolysis of sodium chloride solution in water ? If not, why ?

b) Write down the chemical equation showing the reaction of sodium metal with water.

c) Write down the name of electrolytic cell used to obtain the sodium metal.

d) What is the function of calcium chloride used in the electrolytic cell ?

e) Will sodium metal be formed at cathode ? If so, why ?

f) Write down the chemical equation showing the reaction occuring at cathode and anode in the electrolytic cell.

g) What type of reaction (oxidation or reduction) occurs at the cathode ? Explain.

h) What type of reaction (oxidation or reduction) occurs at the anode ? Explain.

i) Will calcium metal be formed at cathode in the electrolytic cell? If not, why ?

j) Will the sodium metal formed in the electrolytic cell be in solid or in molten state ?

Q.25. A metal carbonate is soluble in water producing an alkaline solution.

When the solution is saturated with carbon dioxide, a white crystalline solid known as baking soda as obtained. Baking soda on thermal decomposition gives the metal carbonate

a) Write down the name and formula of the metal carbonate
b) Write down the formula of the baking powder.
c) Write down the chemical equation showing the formation of baking soda from the reaction of carbon dioxide gas with the solution of metal carbonate in water.
d) Write down the chemical equation showing the thermal decomposition of baking powder.

Q.26. A metal hydroxide is manufactured by the electrolysis of sodium chloride solution in water in an electrolytic cell consisting of mercury cathode and a carbon anode. On electrolysis, the metal is formed at the cathode where it reacts with mercury and forms the metal amalgam. The metal reacts with water in the cell and forms the metal hydroxide.

a) Write down the name and formula of the metal hydroxide.
b) Write down the name of the electrolytic cell used for the manufacture of the metal hydroxide.
c) Write down the chemical reaction occurring at cathode in the electrolytic cell
d) Will the formation of metal, amalgam at the cathode in the electolytic cell be a reduction reaction ? If not, why ?
e) Write down the chemical reaction occuring at the anode in the electrolytic cell.
f) What is the gas evolved at the anode in this process ?
g) Will the reaction occur at the anode in this process ? Explain.
h) Will the metal hydroxide formed in this cell be in solution or in solid form ? Explain.
i) Will the solution obtained in this cell after the electrolysis be acidic, basic or neutral ? Explain.
j) Will any gas evolve at the cathode ? If so, name the gas.

Q.27. A weighed sample consisting of sodium carbonate and sodium bicarbonate were dissolved in water and the volume of the solution was raised to 250 mL 25 mL of this solution was titrated with a standard solution of dil HCl using phenolphthalein as indicator The volume of HCl solution was found to be X mL In another set of experiment, the same volume of the solution was treated with the same standard HCl solution using methyl orange as an indicator. The volume of HCl solution this time was found to be y mL

a) What is the colour of the solution at the end point in the first experiment ?

b) What is the colour of the solution at the end point in the second experiment ?

c) What is the volume of HCl solution required to completely react with sodium carbonate present in 25 mL of the solution ?

d) What is the volume of HCl solution required to react only with the sodium bicarbonate present in 25 mL of the solution ?

e) What is the volume of HCl solution required to react with sodium carbonate and sodium bicarbonate present in 25 mL. of the solution ?

f) Write down the chemical equation for the reaction in the first experiment.

g) Write down the chemical equation for the reaction in the second experiment.

Q 28. Calcium carbonate is stable at room temperature. It decomposes on heating according to the reaction

$$CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$$

The condition for the spontaneity of the reaction is that the standard Gibb's energy for the reaction given by the expression

$$\Delta G_r^{\circ} = \Delta H_r^{\circ} - T\Delta S_r^{\circ}$$

Should be negative For any reaction to be in equilibrium should be equal to zero.

The standard enthalpy (ΔH_r°) and entropy

(ΔS_r°) for the reaction are given by .

$$\Delta H_r^{\circ} = \Sigma \Delta H_r^{\circ} \text{ (Product)} - \Sigma \Delta H_r^{\circ} \text{ (reactant)}$$

$$\Delta S_r^{\circ} = \Sigma \Delta S_r^{\circ} \text{ (Product)} - \Sigma \Delta S_r^{\circ} \text{ (reactant)}$$

Using the data given below work out the problems mentioned below the data :

ΔH_f° (CaO,s) = - 635 kJ mol^{-1}

ΔH_f° (CO_2,g) = - 394 kJ mol^{-1}

ΔH_f° ($CaCO_3$,s)= - 1207 kJ mol^{-1}

ΔS_f° (CaO,s) = 40 JK^{-1} mol^{-1}

ΔS_f° (CO_2, s) = 214 JK^{-1} mol^{-1}

ΔS_f° ($CaCO_3$,s)= - 93 JK^{-1} mol^{-1}

a) Will the reaction occur at room temperature ? If not, why ?

b) Determine the ΔG_r° for the reaction at room temperature (27 °C)

c) Determine the temperature at which the reaction will be in equilibrium i.e.

$$CaCO_3 \text{ (s)} \rightleftharpoons CaO\text{(s)} + CO_2 \text{ (g)}$$

d) will the reaction occur at 513.2 K ?

e) Determine the ΔG_r° at 800 K. will the reaction take place forming CaO (s) and CO_2 (g) at 800 K ? If so, why ?

Q 29. The standard reduction potentials for the half cell reaction are as :

Reaction	Σ^{0} (V)
$Mg^{2+} + 2e^- \rightarrow Mg$	-2.363
$Na^{+} + e^- \rightarrow Na$	-2.714
$Ca^{2+} + 2e^- \rightarrow Ca$	-2.866

A molten mixture consisting of magnesium chloride, sodium chloride, and calcium chloride is electrolysed in the Down's Cell at 973 K. The melting point of magnesium is 924K. It is a strong electro positive metal

with atomic number 12.

a) On electrolysis, which metal will be formed at the cathode ? Why?

b) Will sodium and calcium metals be formed at the cathode ? If not, why? Explain.

c) What type of reaction will take place at the cathode ?

d) What gas will be formed at the anode ?

e) Write down the chemical reaction occurring at the cathode in the cell.

f) Write down the chemical reaction occurring at the anode in the cell.

g) What type of reaction will take place at the anode ? Explain.

h) Will the magnesium formed at the cathode in the cell be in solid form or in molten state ?

i) Indicate the position of magnesium in modern periodic table s p or d block).

j) Will Mg^{2+} be formed in solution ? If not why ?

k) Compare the size of isoelectronic Na^+ and Mg^{2+}.

l) Compare the size of Mg^{2+} with F^-

m) Can magnesium metal be obtained by chemical reduction of its oxide ? If not, why ?

n) What is the function of Mg in plants ?

Q.30. A white solid 'A' is decomposed on heating to form another white solid 'B' along with the evolution of carbon dioxide. The solid 'B' reacts exothermally with water to form a third compound 'C' On passing excess of carbon dioxide gas through a suspension of 'A' in water, a soluble compound 'D' is formed The compound 'D' is present in a sample of hard water along with magnesium bicarbonate. The hard water is made soft by boiling

a) Write down the name and formula of compound 'A'.

b) Write down the name and formula of compound 'B'.

c) Write down the chemical equation showing the thermal decomposition of 'A' to give 'B' and CO_2.

d) What compound is formed when 'B' reacts with water.

e) Is the heat evolved or absorbed when 'B' reacts with water ?

f) Write down the chemical equation showing the formation of 'D' when CO_2 gas is passed through a suspension of 'A' in water

g) Is the compound 'A' water soluble ?

h) Write down the name and formula of compound 'D'.

i) What gas will be evolved if A is treated with dil HCl ?

j) What are the compounds present in hard water ?

k) What happens when hard water is boiled ?

l) Is hard water converted to soft water by boiling ?
If so, write down the reaction.

Q.31. A molten eutectic mixture consisting of alumina, cryolite and fluorspar is electrolysed in an electrolytic cell consisting of carbon anode and carbon lined iron cathode. The electrolysis is carried out at 1173 K. The melting point of aluminium metal is 933 K. It reacts with oxygen to form alumina on heating. Using the following standard reduction potential for half cell reactions and the statements given above, answer the problems given below the standard reduction potentials data

Half cell reaction	Σ^0 (V)
$Al^{3+} + 3e^- \longrightarrow Al$	-1.662
$Na^+ + e^- \longrightarrow Na$	- 2.714
$Ca^{2+} + 2e^- \longrightarrow Ca$	-2.866

a) Which metal will be deposited at the cathode ? Why ?

b) What is the function of cryolite and fluorspar used in the electrolytic cell ?

c) Write down the chemical reaction occurring at the cathode.

d) Will the reaction occurring at the cathode be oxidation or reduction ? Why ?

e) Will sodium/ calcium metal be formed at cathode or not ? Explain.

f) Will aluminium metal formed, in the electrolytic cell, at the cathode, be in the solid form or will it be in the molten state ?

Why ?

g) Can aluminium metal be formed by chemical reduction of alumina ? If not, Why ?

h) Which gas will be evolved at the anode in the electrolytic cell.

i) Write down the chemical reactions occurring at the anode in the electrolytic cell.

j) Will the reaction occurring at the anode in the cell be oxidation or reduction ? Why ?

k) Compare the ionic radius of Al^{3+} with Mg^{2+}.

Q.32. Given below in the table are the atomic numbers and their common ions :

Element	Atomic number	Common ion
Sodium	11	Na^{+}
Fluorine	9	F^{-}
Aluminium	13	Al^{3+}
Nitrogen	7	N^{3-}
Magnesium	12	Mg^{2+}
Oxygen	8	O^{2-}

a) Write down the electronic configuration of each ion.

b) Select the element which is isoelectronic with these ions.

c) Arrange these ions in order of their increasing ionic radii.

d) Will the ionic radius of Mg^{2+} be smaller than that of O^{2-} ? If so, why ?

e) Will the ionic radius of N^{3-} be larger than that of Na^{+} ? If so, Why ?

f) What will be the size relationship between Mg atom and Mg^{2+} ? Explain.

g) What will be the size relationship between N atom and N^{3-} ? Explain.

Q.33. A metal occurs in nature in combined from mainly as its oxides. Its atomic number is 26. The metal reacts with dil H_2SO_4 and forms a light green solution (S_1) which on boiling with conc HNO_3 forms brown solution

(S_2). On adding ammonium thiocyanate solution to solution (S_2), a deep blood red solution (S_3) is obtained. Its oxide can be reduced to the metal by heating with carbon in the blast furnace.

a) Write down the name and symbol of the metal.

b) Indicate the position of the element in the modern periodic table (s, p or, d block)

c) Write down the names and approximate formulae of two oxide ores of the metal.

d) Write down the name and approximate formula of its sulphide mineral.

e) Can the metal be obtained by chemical reduction of its oxide ? If so, why ? Write down the reaction.

f) What will be the suitable reducing agent used to reduce the oxide of the metal in the blast furnace ?

g) In green solution (S_1) the metal is present in which oxidation state ?

h) What is the oxidation state of the metal in brown solution (S_2) ?

i) What is compound formed when ammonium thiocyanate solution is added to brown solution (S_2) ?

j) Can the metal show variable oxidation state ? If so, Why ?

k) Can the metal from complex compound ? If so, Why ?

l) Write down the names and formulae of two complex ions formed by the metal.

m) Write down the chemical equation showing the reaction of the metal with dil H_2SO_4

n) What type of reaction (oxidation or reduction) occurs when green solution is boiled with conc HNO_3 to form the brown solution.

o) Write down the chemical equation showing the reaction during the conversion of green solution to brown solution.

p) Write down the chemical equation showing the reaction during the conversion of brown solution (S_2) to deep blood red solutions (S_3) on addition of ammonium thiocyanate solution

q) Will the oxidation state of the metal be different in solutions (S_2) and (S_3) ?

r) Will the oxidation state of the metal be same or different in solutions (S_1) and (S_2)?

s) Will the oxidation state of the metal be same or different in the solution (S_1) and (S_3) ?

Q 34. The atomic number of a metal is 29. The metal is found in the nature in the combined state as sulphide ore. Malachite is also an important mineral of the metal. The metal reacts with oxygen and forms two oxides one of which is red 'A' and the other is black 'B'. The black compound 'B' dissolves in dil H_2SO_4 and a light blue solution is formed. The solution on evaporation yields a blue pentahydrate crystalline compound 'C' which on heating at 423 K gives a white solid 'D'. The White solid 'D' is again converted to 'C' when exposed to moist air. On adding KI solution to an aqueous solution of 'C' an orange Coloration is produced. On adding hypo solution to the orange solution a milky solution containing a white compound 'E' is obtained.

a) Write down the name and symbol of the metal.

b) Indicate the position of the metal in modern periodic table.

c) Write down the name and forumla of the sulphide ore of the metal.

d) Write down the molecular formula of malachite.

f) Write down the formula of 'A' and 'B'.

f) Write down the chemical equation for the formation of 'A' and 'B' by the reaction of the metal with oxygen

g) Why is the compound 'A' red ?

h) What happens when 'B' reacts with dil H_2SO_4 ? Write down the chemical reaction.

i) Write down the formula of the compound 'C'.

j) What happens when KI is added to an aqueous solution of 'C' ?

k) What happens when hypo solution is added to the orange solution obtained on adding KI to an aqueous solution of 'C' ?

l) Write down the formula of white compound 'E'.

Q.35. Second ionization potential of Ca is higher as compared to its first I.P. inspite of that Ca^{2+} is more stable than Ca^{+} . Formation of O^{-} energy

is released whereas in the formation of O^{2-} energy is absorbed.

a) Explain why Ca^{2+} is not stable

b) Why the second I.P of Ca is higher than the first

c) Explain why the formula of calcium oxide is $Ca^{2+}O^{2-}$ rather than Ca^{+} O^{-} .

d) Calcium does not form any stable compound in which its oxidation state is 3+, Explain Why ?

Q.36. Hydrogen is evolved when water reacts with a white solid 'A' to produce a colourless solution having pH 14. A flame test on solid 'A' gives a liliac flame when 'A' is allowed to stand in air for some hours a damp impure solid 'B' is produced. When 'B' is treated with dil HCl a gas 'C' is evolved.

a) What is 'A' ?

b) What compound will be in impure solid 'B' ?

c) What is gas 'C' ?

Q.37 2 14 g white solid A was treated with dil HCl when CO_2 gas was evolved leaving a colourless solution which was then divided accurately into two equal parts. One part was evaporated to dryness and the white solid residue gave a crimson colour in the flame test The other part was treated with dil H_2SO_4 untill there was no further precipitation. The precipitate was filtered off, washed, dried and was found to have a mass 1.33 g.

a) What is the formula of 'A'.

b) By using the quantitative data how will you confirm the formula of 'A'.

Q 38. The following is a simple account of formation of Mg from sea water Sea water is concentrated and calcium is removed by addition of CO_3^{2-} 'A' The mixture is filtered and clear solution is treated by controlled addition of OH^- ion 'B'. The precipitate is thermally decomposed 'C'

and there residue is converted into $MgCl_2$ 'D'. Mg is then obtained by electrolysis 'E'.

a) Write equations for reaction 'A','B','C','D' and 'E'

b) What is meant by controlled addition

c) Suggest why it is different to produce Mg by heating the residue from the thermal decomposition with carbon.

d) Why Mg compound fail to produce a visible flame colour.

Q.39. Barium sulphide can be formed by strongly heating $BaSO_4$ with carbon.

$$BaSO_4(s) + 4C \longrightarrow BaS + 4CO$$

The can then react with NaOH to give $Ba(OH)_2$. On heating $Ba(OH)_2$, BaO is obtained.

a) Suggest a safety precaution which should be used if $BaSO_4$ was heated with carbon in the laboratory.

b) Barium compounds are toxic and yet patients are some times fed a barium meal. Calculate the percentage yield of BaO if 1.53 g of it is obtained from 4.66 g of $BaSO_4$.
(Hint : atomic mass of Ba = 137)

Q.40. On heating the soft silvery metal 'A' in air it first melted and then gave a yellow solid 'B', further heating 'B' in oxygen produced bright solid 'C'. Treatment of 'C' with HNO_3 gave dark brown solid 'D'. solid 'D' was dissolved in an acidified Nitrite solution Addition of KI to this solution precipited a bright yellow solid 'E' . The solid 'E' was dissolved in hot water to give a colourless solution but yellow crystals 'E' separated on cooling.

a) Identify 'A' to 'E'.

b) Give chemical equations involved in all the reactions.

Q 41. Study the Graph showing the boiling points of various compounds.

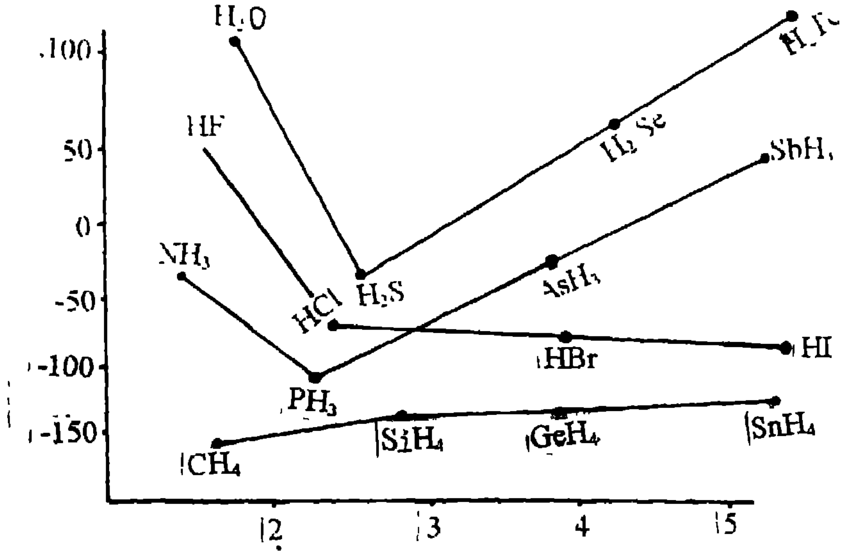


Fig. 17

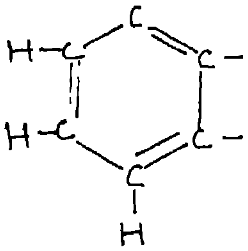
a) Suggest a reason for the regular increase in boiling point from CH_4 to SnH_4

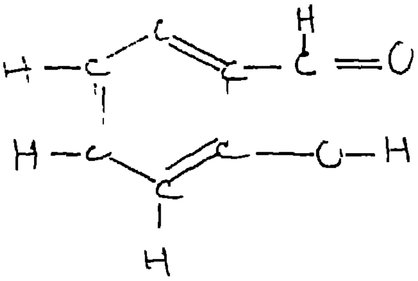
b) What is responsible for the anamalously high boiling point of NH_3, HF and H_2O ?

c) Carefully explain with the aid of a diagram the nature of the forces between molecules of water.

Q.42. **Step-I**

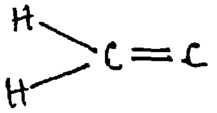
Below are given the formulae of certain compounds. In which of them the hydrogen bonding is impossible


(A)


(B)

H - Cl

(C)


(D)

CH_3OH

(E)

CH_4

(F)

CHF_3

(G)

$CHCl_3$

(H)

SiH_4

(I)

Step-II

Sketch the structure of NH_3 and NF_3 and compare them on the following basis

a) Each molecule has a dipole moment In each molecule towards which end does the negative portion of dipole lie

b) Give a possible explanation for the fact that the dipole moment NH_3 is 1.47 D, whereas that of NF_3 is only 0 234 D

Q.43. Suppose a new element, tentatively given the symbol 'Et' has just been discovered. Its atomic number is 113

a) Depict the electronic configuration of the element

b) Name another element you would expect to find in the same group as 'Et' with its possible atomic number.

c) Give the formulae for the compounds of 'Et' with oxygen and chlorine

Q 44 BCl_3 reacts with NH_3 at room temperature to form a compound 'P It also reacts with NH_4Cl at 170 °C to form a compound 'Q'. 'Q' undergoes reduction to give a volatile liquid 'R'.

a) Identify 'P', 'Q' and 'R'.

b) Why is 'Q' more reactive as compared to Benzene

Q 45. The action of PCl_5 on H_2SO_4 yields compound 'A', which reacts with anhydrous hydrogen peroxide to yield 'B' and 'C'. When 'A' is heated in a sealed tube it forms equimolar amounts of H_2SO_4 and 'D'.
Identify 'A', 'B', 'C' and 'D'.

Q 46. When SO_2 reacts with Cl the products are $SOCl_2$ and Cl_2O.

$$SO_2\,(g) \;+\; 2Cl_2\,(g) \longrightarrow SOCl_2\,(g) \;+\; Cl_2O\,(s)$$

a) In what period of the periodic table is 'S' located ?

b) Give the electronic configuration of 'S'

c) Using your configuration at (b) give set of quantum number assigned for the last electron in 'S'

d) What element involved in this reaction (O,S,Cl) should have the smallest I.E. and the smallest radius

e) Which should be smaller the S^{2-} or the 'S' atom

f) If you want to make 675 g of $SOCl_2$, how many grams of Cl_2 are required

Q.47. ClF_3 is one of the most reactive compound known. It reacts violently with many substances generally thought to he inert, and was used in incending bombs in the world war II.
(Hint It can be made by heating Cl_2 and F_2 in a closed container)

a) Write a balanced equation to depict the reaction of Cl_2 and F_2 to give ClF_3

b) If you mix 071g of Cl_2 with 1.00 g of F_2, how many grams of ClF_3 are expected ?

c) Draw the electronic configuration of ClF_3

d) What is the structural pair geometry for ClF_3

Q.48 The decomposition temperatures of the group II Carbonates are given below

$BeCO_3$	$MgCO_3$	$CaCO_3$	$SrCO_3$	$BaCO_3$
370K	470K	1170K	1550K	1630K

a) Write the equation for the thermal decomposition of the carbonate ion giving state symbols.

b) Suggest a reason that causes the variation in decomposition temperature.

Q.49. Large quantities of Mg are used in the extraction of the element titanium (Ti). In this process Ti (IV) chloride is reacted with Mg to produce $MgCl_2$ and Ti.

a) Write equation for this reaction.

b) What mass of Mg required to react with 3.8 tonnes of $TiCl_4$

Q.50. In which group of periodic table would you find the following elements ('A','B' and 'C') ·

a) 'A' forms a close packed non conducting solid

b) 'B' shows a coordination of three in the solid state which consists of packed sheets held together by metallic type bond

c) 'C' forms a red solid consisting of packed rings of atoms

Q.51 Typical results for I P. (kJ mol^{-1}) are as follows ·

Ist	IInd	IIIrd	IVth	Vth
+800	+2400	+3700	+25000	+32800

a) Plot $\log_{10}$ (I.P.) against the no of electrons removed

b) label the graph at each point with the electronic configuration (s,p) of the corresponding electron removed.

c) Deduce from the graph with explanation the most likely formula of boron oxide

Q 52 Two elements whose symbols are 'X' and 'Y' form the compounds XCl and YCl respectively XCl is a gas. YCl is a solid, which dissolves in water to form a solution which conducts electricity.

a) In which group of the periodic table is 'X' located ?

b) In which group of periodic table is 'Y' located ?

Q 53. Consider the following information about compounds of elements with hydrogen

-sodium hydride (NaH) is an ionic compound.

-Magnesium hydride (MgH_2) is an ionic compound.

-Methane (CH_4) is a covalent compound.

-Ammonia (NH_3) is a covalent compound.

-Water H_2O is a covalent compound

-Hydrogen Fluoride (HF) is a covalent compound

-Neon does not form a compound with hydrogen.

a) Explain, why the composition of these compounds are different ?

b) Explain why some hydrogen compounds are ionic and some are covalent ?

Q.54 0 347g of metal 'A' was dissolved in dil HNO_3. This solution gave red coloration to a non-luminous Bunsen flame and on evaporation gave 0 747 g of metal oxide 'B' 'A' also reacted with N_2 forming a compound 'C and with hydrogen forming 'D' On reacting 0 15908 g of 'D' with water a gas 'E' was evolved and a sparingly soluble compound formed which gave strongly basic reaction and required 200mL of 0 1N HCl to neutralize it

a) Identify 'A', 'B', 'C', 'D', 'E' and 'F'.

b) Give all the chemical equation involved.

c) Justify your answer on the basis of calculations.

Q 55 On treatment with cold water, an element 'A' reacted quietly liberating a colourless and odourless gas 'B' and a solution 'C' which reacts with 'B' yielding a solid product 'D' which dissolves in water to give a strongly basis solution 'E' When CO_2 was bubbled through solution 'E' initially a white ppt, 'F' was formed but this redissolved forming solution 'G'. When more CO_2 was added, ppt 'A' effervesced and when moistened with conc HCl, gave a deep red coloration to a bunsen burner flame. When 'A' was heated with carbon at 1000 °C, a caustic white compound 'H' was formed which when heated with carbon at 1000°C gave a solid 'I' of some commercial imortance.

a) Give the name of the substance 'A', 'B', 'C', 'D', 'E', 'F', 'G', 'H' and 'I'

b) Give balanced equations of the various steps

Q.56. When a white substance 'A' was heated with dil HCl, a colourless gas 'B' was evolved, which turned moist litmus paper red. On bubbling 'B' through lime water a ppt 'C' was formed but passage of further gas resulted in a clear solution 'D' A small sample of 'A' moistened with conc HCl and placed on Pt wire and heated, produces a green flame. On strong heating 'A' decomposes giving white solid 'E', which turned red litmus paper [illegible] 1 9735 g of 'A' was heated strongly and gave 1.5334 g of 'E' A sample of 'E' was is dissolved in H_2O and made upto 250 mL 25 mL of this solution was titrated with HCl which required 20.3 mL of 0 0985 M HCl.

a) Give the name of the substance 'A', 'B', 'C', 'D', and 'E'

b) Give balanced equations of the various steps

Q.57. Given below are the electron affinity values of the 2nd period elements

Element	**Electron affinity** (kJ mol^{-1})
Li	-52
Be	+66
B	-29
C	-120
N	-3
O	-142
F	-348

Why do you think that the electron affinity values of Be and N differ markedly from the other elements of the period ?

Q.58. Given below are certain melting and boiling points :

	m.p.^{0}C	**b.p.^{0}C**
Li	180.5	1347
Be	1287	2500
B	2180	3650
N_2	-210	-1985
O_2	-183.0	218.8
F_2	-188.0	218.6

Why do you think that there is generally a greater difference between the mp and bp for metals, then for non-metals ?

Q.59 Element 'Y' has atomic number 31. Use your knowledge of chemical periodicity to answer the following questions about 'Y' :

a) Write the electronic configuration (s,p,d,f) of Y.

b) Is element Y in the s block, p block or d block ?

c) What is the principal oxidation number of 'Y' ?

d) What is the probable formula of the oxide of 'Y' ?

e) Is the oxide of 'Y' likely to be amphoteric, acidic or basic ?

Q.60. Given below are the properties of the chlorides of elements of the 3rd period.

Formula of Chloride	$NaCl$	$MgCl_2$	Al_2Cl_6	$SiCl_4$	PCl_3	S_2Cl_2	Cl_2
State of chloride at 20°C	s	s	s	l	l	l	g
bp of chloride °C.	1465	1418	423	57	71	136	-35
Conduction of elelectricity by molten or liquid chloride	good	good	v.poor	nil	nil	nil	nil
Structure of chloride	Giant	structure	Simple	molecular		Structure	
Heat of formation of chloride at 298K/mol of Cl atom (kJ)	-411	-321	-235	-160	-107	-30	0
PH of liquid solution of chloride	7	6 5	3	2	2	2	2

Based on the given table, answer the following :

a) Why are the bp's the NaCl and $MgCl_2$ considerably higher than the rest of the chloride ?

b) Why are the electrical conductivities of molten NaCl and $MgCl_2$ good, but in those of the rest of the chlorides is bad ?

c) Why is there a gradual decrease in the heat evolved when the elements react with 1 mol, of chlorine ?

d) Explain the pH values of the aqueous solution of the chlorides.'

e) Attempt to write equations to explain your answer in (d) above.

Q.61. Study the following reactions .

$X^-(s)$ + Conc H_2SO_4 (1) $\longrightarrow$ HX + HSO_4^- ------- (1)

$X^-(s)$ + Conc H_2SO_4 (1) $\longrightarrow$ X_2 + $2H_2O$ + SO_2 -----(2)

Which of these two reactions do you think will be applicable when $X^- = F^-$ and $X^- = I^-$? Justify your answer.

Q.62. Explain the following :

a) Na_2O, the oxide of a group 1 metal, reacts vigorously with water to form an alkaline solution. Suggest reaction to support.

b) MgO, an oxide of a group 2 metal, does not react readily with water, why ?

c) Anhydrous $CaCl_2$ can be obtained by heating $CaCl_2$ $2H_2O$, whereas anhydrous $MgCl_2$ cannot be obtained by heating $MgCl_2$ $2H_2O$.

Questions
on
Physical Chemistry
(Class - XII)

Q.1. Examine the following data listing the most abundant ions present in sea water .

Ion	**Molality mol/kg**
Chloride	0.566
Sodium	0.486
Magnesium	0.055
Sulphate	0.029
Calcium	0.011
Potassium	0.011
Bicarbonate	0.002

a) Calculate the weight (in grams) of each component contained in 3.0 L of sea water whose density is 1.024g mL^{-1}

b) 300mL sample of the sea water was completely evaporated and the residue left was weighed. What is the weight of the residue ?

c) What is the normal boiling point of sea water ? (K_b for water= 0.51 K kg mol^{-1})

d) A 30 mL sample of the sea water was acidified with dil HNO_3 and a slight excess of $AgNO_3$ was slowly added, when a white precipitate appeared. Identify the precipitate and find out the weight of the precipitate thus obtained.

e) What is the molarity of magnesium ion in the sea water ?

Q.2 An ideal solution is the one which obeys Raoult's law accurately over the entire range of concentrations. Benzene and toluene make an ideal solution. At 25°C the vapour pressures of benzene (C_6H_6) and toluene (C_7H_8) are :
93 4 and 26.9 torr respectively.

a) At what applied pressure, (in atmospheres) will a mixture of solutions containing 50.0 g each of benzene and toluene boil at 25°C?

b) The vapours initially formed from the above solution were removed

from solution and condensed separately. What is the composition of the condensate in terms of the following .

i) mole fraction.

ii) mass percentage of benzene.

iii) molality of benzene in toluene.

iv) molality of toluene in benzene.

c) If the condensate is also to be boiled at 25 °C, how much pressure (in atmosphere) must be applied on it. Is it more or less than the applied pressure required in (a) earlier ? Give reason for your answer.

d) Will the entire solution boil off under a constant applied pressure and at a constant temperature as in questions 'a' or 'c' ? Give reasons for your answer.

Q.3. Study the following data in the table given below :

Temperature (°C)	**Vapour pressure of ice (torr)**	**Vapour pressure of water (torr)**
-10	1.956	2.149
-5	3.018	3.162
-4	3.285	3.402
-2	3.884	3.957
2	- -	5.292
5	- -	6.542
10	- -	12.788

a) Plot a graph between temperature and vapour pressure and determine the freezing point of water from it.

b) What will be the vapour pressures of a 15% solution of urea by mass in water at various temperatures given in the following table.

Temperature ($^\circ$C)	**Vapour pressure** (torr)
-4	
-2	
2	
5	
10	

Plot this data also on the same graph paper which was used in part (a) and determine the freezing point of the urea solution.

c) Calculate the molal depression constant K_f for water from the information now available to you. What are its units ?

d) Calculate Δ H fusion 'for water.

Q.4. Vapour pressures of chloroform and acetone are 143 and 397 torr respectively at 17°C. Assuming that they form ideal solution, calculate and plot $P_{CH_3COCH_3}$, P_{CHCl_3} and P_{total} against X_{CHCl_3} The experimental data for the system is given below :

(torr)

X_{CHCl_3}	0	0.2	0.4	0.6	0.8	1.0
P_{CHCl_3}	0	13	34	71	104	143
$P_{CH_3COCH_3}$	397	304	196	95	32	0

a) What kind of deviation, positive or negative, is shown by the system ?

b) Normally, on boiling a binary solution of volatile liquids, its composition and boiling point changes. Can you identify from the graph, a solution which will boil at a constant temperature without undergoing a change in its composition. What is X_{CHCl_3} in this solution ? What is the name of such a solution ?

c) A solution having X_{CHCl_3} value 0 45, was subjected to fractional distillation Identify the condensate and residue

Q.5. In certain electrochemical measurements, the following electrode is to be used as a reference electrode.

Ag, AgCl | HCl (x)

Its electrode potential is known to be 0.2841 at 298 K. E^0 of this electrode is 0.2225 V at 298 K.

a) Calculate the molarity (x) of the HCl solution.

b) What is the molality of the HCl solution if its density is 1.012g mL^{-1} at 298K ?

c) If the electrode is to be used in cold region, what is the minimum temperature up to which this electrode can be used ?

K_f for water = 1.86 K kg mol^{-1}.

(Hint : The electrode will stop functioning when its electrolyte is frozen).

Q.6. When a non-volatile solute is dissolved in a solvent, the solution boils at a temperature higher than the temperature when the pure solvent boils. The elevation of boiling point is a colligative property.

a) Draw vapour pressure-temperature diagram. Show and explain the elevation in the boiling point phenomenon.

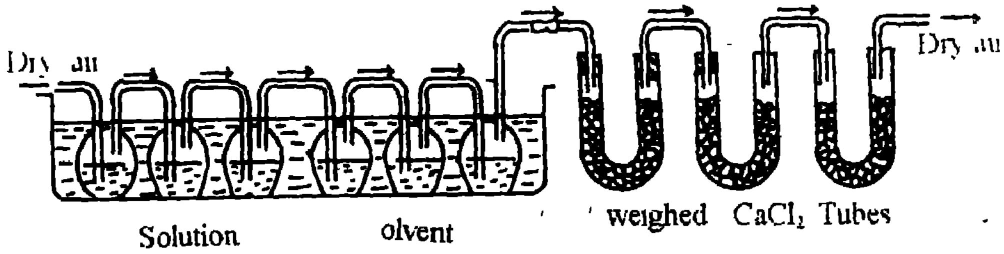
b) What is meant by the term "colligative property" ?

c) Name two other colligative properties.

d) Explain why the measurement of elevation in boiling point can be used for determination of molar mass of sucrose but not that of methanol ?

e) A 6 0% solution by mass of a compound X in water has the same boiling point as a 4% solution by mass of sucrose $C_{12}H_{22}O_{11}$ in water. Calculate the molar mass of X

Q.7. Given below is the experimental set up for the measurement of relative lowering of vapour pressure by Ostwald and Walker's method.



(Fig. 18)

A stream of dry air is slowly bubbled through first set of bulbs containing a solution and then through another set of bulbs containing pure solvent and finally through a set of U tubes containing $CaCl_2$.

When dry air is bubbled through a liquid (solution or pure), it becomes saturated with its vapours. The mass of vapours carried by it is proportional to the vapour pressure of the liquid.

a) What is relative lowering of vapour pressure ?

b) Give its relationship with the composition of the solution in terms of masses and molar masses of the solute and the solvent.

c) If W_1 is the loss in the weight of first set of bulbs containing solution and W_2 is the loss in weight of second set of bulbs containing pure solvent, then how will you calculate relative lowering of vapour pressure of the solution ?

d) Dry air was passed successively through a solution of 10 g of a solute dissolved in 90 g water and then through pure water. The loss in weight of the solution was 2.5 g while that of pure water was 0.05 g . What is the molecular mass of the solute ?

Q 8. Osmosis is the main phenomenon which causes soil water to rise from the roots to the treetop.

a) Explain the term osmosis and define osmotic pressure.

b) What is a semipermeable membrane and what is its role in osmosis ? Give two examples.

c) What are isotonic solution ?

d) The tallest tree known are the redwoods in California. Assuming the height of a redwood to be 105m, estimate the osmotic pressure required to push water up from the roots to the tree top.

e) What must be the average concentration (molarity) of dissolved substances in the fluids present in the redwood trees to be able to suck water by osmosis upto their tops at 300 K.

Q.9. Conc H_2SO_4 is one of the most important reagent used in the laboratory.

a) The conc H_2SO_4 used in the laboratory is 98.0% sulphuric acid by mass. Calculate its molarity and molality if its density is 1.83 g cm^{-3}.

b) Dil H_2SO_4 used in the laboratory is 2.5 M. What volume of conc H_2SO_4 whose strength has been calculated in part (a) is required for preparing 5 litre dil H_2SO_4 ?

c) Osmotic pressure of dil H_2SO_4 determined at 300 K is 157 atm. What is its apparent degree of dissociation.

Q.10. Colligative properties are used in many walks of life.

a) Salt-ice mixture are called freezing mixture. They are used for producing low temperatures for cooling purposes. What is the role of salt in the freezing mixture ?

b) Ethylene glycol $CH_2(OH)$. $CH_2(OH)$ is a common antifreeze for car radiators.

   i) What is an antifreeze ?

   ii) What is the role of ethylene glycol in it ?

   iii) Should antifreeze be kept in the car radiator during summer season or not ? Give reason of your answer.

c) Making jams, jellies and pickles are different ways of food preservation. For their preparation a very large concentration of sugar or salt is used. How does it help in the preservation

process ?

d) Reverse osmosis is a method which is now being increasingly used for desalination of sea-water.

   i) What is desalination ?

   ii) What is reverse osmosis ?

   iii) Osmotic pressure of sea water is about 50 atm. How much minimum pressure has to be created for desalination ?

e) In cold regions, roads get covered with snow and they have to be periodically cleared. For this purpose usually salt is sprinkled on the snow-bound roads. How does it help in clearing the roads ?

Q.11. Predict the entropy changes of the following reactions :

a) $H_2(g) + I_2(s) \rightarrow 2HI(g)$

b) $HCl(g) \rightarrow H(g) + Cl(g)$

c) $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$

d) $CaO(s) + 2NH_4Cl(s) \rightarrow 2NH_3(g) + CaCl_2(s) + H_2O(g)$

e) $CO_2(g) + CaO(s) \rightarrow CaCO_3(s)$

f) $4NH_3(g) + 3O_2(g) \rightarrow 2N_2(g) + 6H_2O(g)$

g) $NH_3(g) + HCl(g) \rightarrow NH_4Cl(s)$

Q.12. The body eliminate ethanol by oxidation to give water and the following series of carbon containing products,

$$C_2H_5OH \xrightarrow{O_2} CH_3CHO \xrightarrow{O_2} CH_3COOH \xrightarrow{O_2} CO_2$$

a) Write balanced equations for each step during oxidation.

b) What is the overall ΔH^o for complete oxidations of ethanol to CO_2 and H_2O ?

[Hint : ΔH_f^o, $CO_2(g)$ = -394 kJ ; ΔH_f^o, $H_2O(l)$ = -283 kJ
ΔH_f^o, $C_2H_5OH(l)$ = -278 kJ.]

Q.13. Two heat engines are working between temperatures T_1, T_2 and T_3 as shown in the figure below :

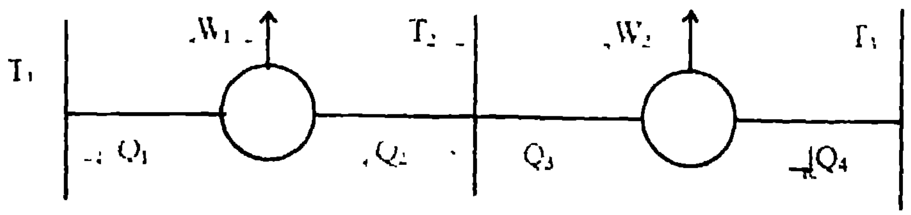


Fig.19

Find out the relations between T_1 , T_2 and T_3

i) If the two engines have the same efficiencies.

ii) If two engines do the same amount of work.

iii) If T_1 = 1500 K and T_3 = 300 K, calculate T_2 in each case.

Q.14. One mole of perfect gas expands isothermally and reversibly at 0°C from 1 to 1/10 bar pressure. Further, one mole of the same gas in 22.8 L vessel is allowed to expand irreversibly into an evacuated vessel such that the final volume is 228 L Calculate Wrev, ΔH, ΔG and ΔS in each case ($R = 8.314\ JK^{-1}\ mol^{-1}$).

Q.15. The standard heats of formation of acetylene gas and ethylene gas are found to be 226 kJ mol^{-1} and 51.9 kJ mol^{-1} respectively. Work out the bond energies of C-H and C≡C bonds and estimate the heat of combustion of acetylene from the following data :

ΔH_f^o, H_2O (l) = 286 kJ mol^{-1}

ΔH_f^o CO_2 (g) = 94.1 kJ mol^{-1}

ΔH_f^o, C (g) = 715 kJ mol^{-1}

ΔH_f^o, H (g) = 218 kJ mol^{-1}

Work out all the thermochemical steps involved.

Q.16. The formation of methane from Coal at 500 K is represented by the following steps ·

i) 2 C(Graphite) + $2H_2O$ (g) = 2 CO (g) + $2H_2$ (g)
ii) CO (g) + H_2 O (g) = $CO_2 + H_2$ (g)
iii) CO (g) + $3H_2$ (g) = CH_4 (g) + H_2O (g)
The overall reaction is
iv) 2 C (grahite) + $2H_2O$ (g) = CH_4 (g) + CO_2 (g)

a) What is ΔH^o for each of these reactions (i) to (iii) at 500 K ?
b) Show that the sum of ΔH^o of the first three reactions is equal the ΔH^o for the reaction (iv)

Q.17. Standard heat of reaction (ΔH^o) for the following reactions at 25^oC are given below :

i) H_2 (g) + $\frac{1}{2}O_2$ (g) $\rightarrow H_2$ O (g) ; ΔH^o = -241.83 kJ mol^{-1}
ii) C_6H_6 (g) + $\frac{15}{2}O_2$ (g) $\rightarrow$ 6 CO_2 (g) + $3H_2O$ (g) ; ΔH^o = -3301.5 kJ mol^{-1}
iii) C_2H_2 (g) + $\frac{5}{2}O_2$ (g) $\rightarrow$ 2 CO_2 (g) + H_2O (g) ; ΔH^o = -1299.6 kJ mol^{-1}
iv) CH_3 COOH (1)+ 20_2 (g) $\longrightarrow$ 2 CO_2 (g)+ $2H_2O$ (g); ΔH^o= -872.4 kJ mol^{-1}
Calculate the values of standard heat of reaction (ΔE^o) at constant volume for each reaction

Q.18. The following process is carried out at 1 atm pressure and at a temperature of 78.5^oC.

3 mol C_2H_5OH (l) $\rightarrow$ 3 mol C_2H_5OH (g)

If the heat of vapourisation of C_2H_5OH is 7.15 Jg^{-1} and its density at 78.5^oC be 0.7893 kg dm^{-3}, then calculate the values of V_1V_2W, Q, ΔE and ΔS. It is assumed that vapours are behaving ideally.

Q.19. The following reactions take place at 100^oC .

i) C_6H_6 (g) + $\frac{15}{2}O_2$ (g) $\rightarrow$ $6CO_2$ (g) + $3H_2O$ (g)
ii) $2C_2H_6$(g) + 7 O_2(g) $\rightarrow$ 4 CO_2(g) + 6 H_2O (l)
iii) CO_2(g) + H_2 (g) $\rightarrow$ CO (g) + H_2O (g)

iv) $H_2O_2(g) \rightarrow H_2O\ (g) + \frac{1}{2}O_2\ (g)$

Find out the difference in the value of change in Gibbs free energy and Helmhotlz free energy for each reaction

Q.20. The cyclisation of 1-pentene takes place at 25°C by the reaction

1-pentene $\rightleftharpoons$ Cyclopentene

The respective standard values of ΔH_f for 1-pentene and cyclopentene are -77.40 kJ mol^{-1} and 32.98 kJmol^{-1} whereas that of S_f^o are 292.88 JK^{-1} and 289.53 J K^{-1}.

a) Calculate the free energy of the formation of each species and of the entire process.

b) Assuming that gases do not transform into each other, calculate the free energy of each species in a mixture containing X_1 -pentene = 0.728 and $X_{cyclopentene}$ = 0.272 and each gas at a pressure of 1 atm, where x is the mole fraction.

Q.21 We know that acetylene (C_2H_2) gas is used in welding. It is produced by the action of water on calcium carbide (CaC_2). A few thermochemical equations are as follows :

i) $CaO(s) + H_2O\ (1) \rightarrow Ca\ (OH)_2\ (s)$, ΔH^o + -156 k Cal

ii) $CaO\ (s) + 3\ C\ (s) \rightarrow CaC_2(s) + CO$; ΔH^o = + 110.5 k Cal

iii) $CaC_2(s) + 2H_2O\ (1) \rightarrow Ca\ (OH)_2\ (s) + C_2H_2\ (g)$; ΔH^o + -30.0k Cal

iv) $2C\ (s) + O_2\ (g) \rightarrow 2CO\ (g)$; ΔH^o = -52.8k Cal

v) $2H_2O\ (1) \rightarrow 2\ H_2\ (g) + O_2\ (g)$; ΔH^o = + 136.6 k Cal

Calculcate ΔH_f^o for acetylene and express your answer in both kJ mol^{-1} and k cal mol^{-1}

Q.22. For 1 mol cf water molecules, the following data are available :

Heat capacity of the liquid = 75.5 JK^{-1} mol^{-1}
Heat capacity of the vapour = 33 8 JK^{-1} mol^{-1}
Normal boiling point = 100°C
The enthalpy of vaporization at 100°C = 40, 670 J mol^{-1}
The enthalpy for the vaporization at 0°C = 44,800 J mol^{-1}
Vapour pressure of water at O°C = 0.00602 atm.

Show by diagrametic representations, how the following process can be carried out in atleast two different ways and show that the entropy change is independent of them :

H_2O (l) (0.1atm, O°C) → H_2O (g) (1atm, 100°C)

Q.23. If ΔS is the entropy difference of a chemical or physical change proceeding from one state A to another state B. Predict the sign of ΔS_{univ} in the following processes :

a) The process tends to proceed spontaneously from state A to state B.

b) The process tends to go spontaneously in the reverse direction, i.e., from B to A.

c) The system is in equilibrium and no spontaneous process occurs.

Q.24. The entropy of N_2 gas is measured by Giauque and Clayton (1933) using calorimetric data. The heat capacity, Cp was measured as a function of temperature, T, and the heats of various transitions, occuring below 298.15 K were determined along with the transition temperatures. The experimental values of Cp obtained were plotted against T, as shown below.

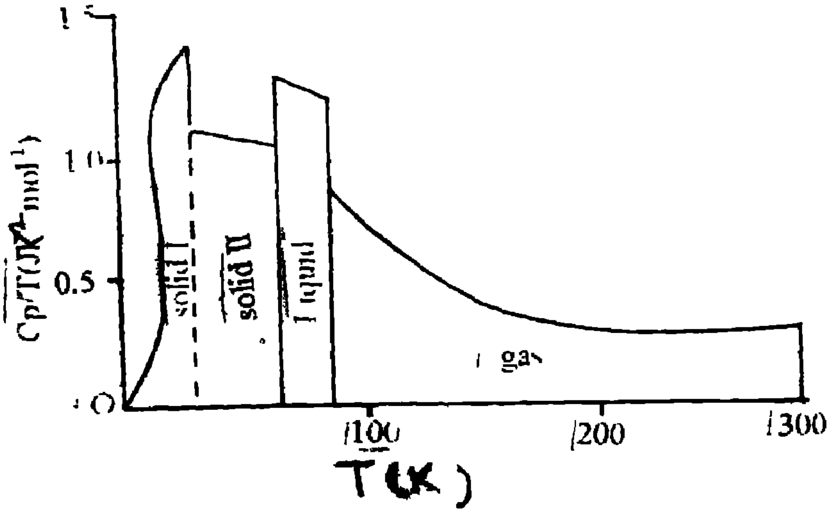


Fig.20

It was not possible to measure Cp below 10 K. At 35.61 K, the following transition was observed :

$$N_2(s, I) \longrightarrow N_2(s, II)$$

The heat of this transition being 228.9 JK^{-1} mol^{-1}. The heat of fusion and vaporization were found to be 720.9 JK^{-1} mol^{-1} and 5535.0 JK^{-1} mol^{-1}. 63.14 K and 77.32 K are respectively the fusion and boiling temperatures. The following data were obtained by thermal measurements :

Temperature Range	**S (JK^{-1})**
i) 0K to 10 K (Debye Extrapolation method)	1.92
ii) $\int_{10}^{35.61} C_p d\ln T$ (graphical method)	25.25
iii) N_2 (s, I, 35.61 K) = N_2 (s, II, 35.61 K) (Transition)	6.43
iv) $\int_{35.61}^{63.14} C_p d\ln T$ (graphical method)	23.38

v) N_2 (s,II, 63 14 K) = N_{ℓ} (l,63.14K) (fusion) 11.42

vi) $\int_{63.14}^{77.32} C_p d\ln T$ (Graphical Method) 11.41

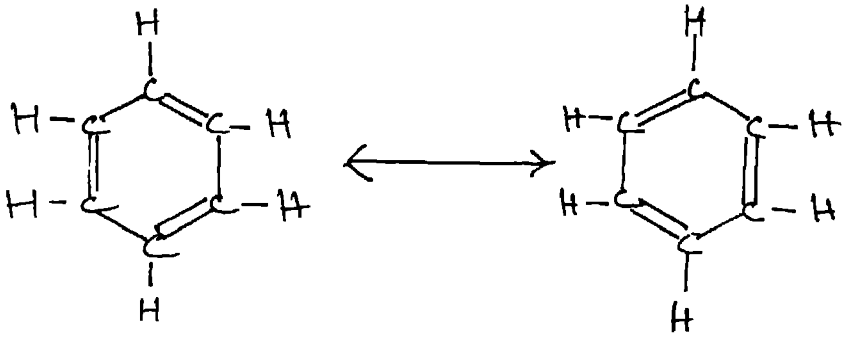
vii) N_2 (l, 77.32 K) = N_2 (g, 77.32K) (vaporisation) 72.13

viii) $\int_{77.32}^{298.15} C_p d\ln T$ (Grahical Method) 39.20

ix) N_2 (g, real, 1 bar, 298.15 K) = N_2 (g), ideal, 1 bar, 298.15) 1.03 (correction due to gas imperfection)

Give the procedure for estimating the ideal value of entropy for N_2 (g) in the standard state i.e. at 298.15 K and 1 bar pressure.

Q.25. Benzene is often written as a resonance hybrid of two equivalent structures,



The ΔH_f for gaseous benzene has been determined from the heat of combustion to be + 82.2 $kJmol^{-1}$

$$6C(s) + 3H_2(g) = C_6H_6(g) \; ; \; \Delta H_f^o = +82.2 \, kJmol^{-1}$$

a) Calculate ΔH_f^o from the data given below.

$\underline{C}$ (s) $\longrightarrow$ C (g) ; ΔH^o = 715 kJ

$\frac{1}{2}H_2(g) \longrightarrow H(g) \quad ; \Delta H^{o}_{at} = 218$ kJ

$\Delta H_{C-H} = 415$ kJ

$\Delta H_{C-C} = 348$ kJ,

$\Delta H_{C=C} = 463$ kJ

Q.26. The boiling point of ethanol is 351.2 K at 1 bar pressure and its heat of vaporisation is 38.57 kJ mol^{-1}

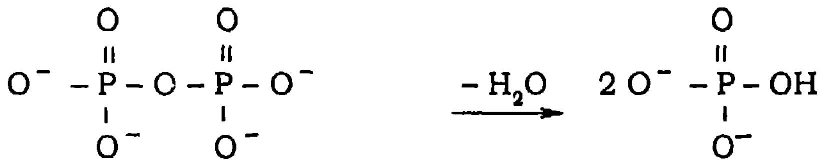
How much change in entropy does take place when 1 mol of liquid ethanol is converted into ethanol vapour at a pressure of 1 bar ?

Q.27. The enthalpy change of the graphite → diamond phase transition, is 1.90 kJ mol^{-1} at 100 k bar pressure and at 2000 K,

a) Calculate the entropy change of the phase transition at the transition temperature .

b) Does the result obtained in (a) show that graphite and diamond have different crystal structures ?

Q.28. At sufficiently high pH (pH > 8) and sufficiently high pMg (pMg > 5), the value of standard Gibbs free energy change, ΔG^{o} for the reaction.



$$O^- - \overset{\overset{O}{\|}}{\underset{\underset{O^-}{|}}{P}} - O - \overset{\overset{O}{\|}}{\underset{\underset{O^-}{|}}{P}} - O^- \xrightarrow{-H_2O} 2\,O^- - \overset{\overset{O}{\|}}{\underset{\underset{O^-}{|}}{P}} - OH$$

(pyrophosphate ion) (phosphate ion)

Can be calculated with only having the following informations at 25°C.

$P_2O_7^{4-} + H_2O \rightleftharpoons HPO_4^{2-} \; ; \Delta G^{o} = -44.56 \text{ kJ mol}^{-1}$

$HP_2O_7^{3-} \rightleftharpoons H^+ + P_2O_7^{4-} \; , \Delta G^{o} = 51.09 \text{ kJ mol}^{-1}$

$MgP_2O_7^{2-} \rightleftharpoons Mg^{2+} + P_2O_7^{4-} \; ; \Delta G^{o} = 30.92 \text{ kJ mol}^{-1}$

What is the value of the equilibrium constant i.e.

$\frac{[\text{Phosphate}]^2}{[\text{Pyrophosphate}]}$ at pH = 9 and pMg = 6 ?

Q 29. The overall reaction of the discharge of a storage battery is.

$$Pb(s) + PbO_2(s) + 2H_2SO_4(l) \rightarrow 2PbSO_4(s) + 2H_2O(l)$$

The standard free energies of formation of PbO_2 (s), H_2SO_4 (l), $PbSO_4$ (s) and water are -217.38 kJ mol^{-1}, -909.27 kJ mol^{-1}, -813.20 kJ mol^{-1} and -237.18 kJ mol^{-1} respectively

a) Calculated ΔG^{o} for the reaction.

b) Represent the cell formed and write down the half cell reactions.

c) Calculated the e.m.f. of the cell.

d) Predict whether the reaction is spontaneous or not ?

Q.30. An electrochemical cell can be set up with hydrogen gas being the reactant at one electrode and oxygen gas the reactant at the other electrode. The product of the cell reaction is water. The electrolyte can either be an acid or an alkali.

a) Assuming hydrogen electrode on the left and oxygen electrode on the right, represent the polarity of the electrode, write down the cell reactions in both the cases i.e. in acidic and alkaline media.

b) At 25°C and with the gases each at a pressure of 1 bar, this cell has the e.m.f of 1.229 V. Calculate the maximum energy that could be obtained by the combustion of 1 mol of hydrogen.

Q.31. The molar conductances of sodium propionate at 25° C are as under :

conc mol L^{-1}	0.002718	0.004180	0.007870	0.01427	0.02597
Molar conductance $Sm^2 mol^{-1}$	0 008253	0.008127	0 007972	0 007788	0.007564

Molar conductances of NaCl and HCl at infinite dilution are 0.012645 S m^2 mol^{-1} and 0 042616 S m^2 mol^{-1} respectively.

a) What is the limiting molar conductance of sodium propionate ?

b) What is the limiting conductance of propionic acid ?

c) At a concentration of 1 M, the molar conductance of propionic acid is 1.4×10^{-4} S m^2 mol^{-1}. What is the degree of dissociation of propionic acid in this solution ?

d) Calculate the dissociation constant for propionic acid at 1 M.

Q.32. The e.m.f of concentration cell with an aqueous cadmium chloride as electrolyte and with one of the electrodes consisting of an amalgam containing 10 mg of cadmium per gram of mercury and the other electrode containing 1 mg cadmium per gram of mercury was found to be 0.02966 V at 25°C.

Other concentrations, with one amalgam being 10 times as concentrated as the other, were also used. The emf varies slightly and was 0.02950 V for amalgams made up with 0.01 mg and 0.001 mg of cadmium per gram of mercury ;

a) Represent the electrodes and write down the cell reactions.

b) Calculate emf of these cells ?

c) What does the near constancy of the emf in the given concentration range imply ?

Q.33 The specific conductivity of an aqueous solution of an electrolyte at 298 K when plotted against concentration gives the following graph. The solid line shows the actual variation of conductivity with concentration, while the dotted line shows the expected trend, if conductivity depends solely on number of ions present in unit volume of the solution.

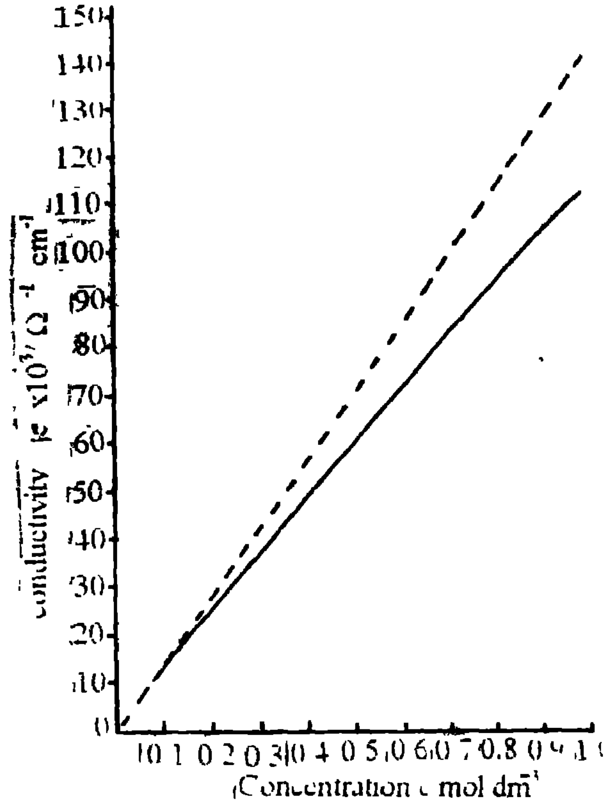


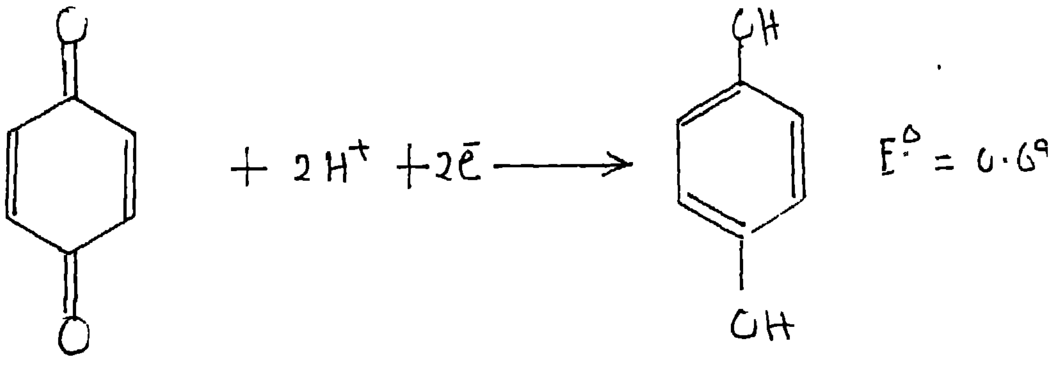
Fig.21

a) What conclusion can be drawn from dotted line regarding number of ions per unit volume ?

b) What conclusion can be drawn regarding the nature of electrolyte on the basis of above graph ?

c) What is the reason for the actual behaviour which is shown by solid line ?

Q.34. A well known organic redox system is the quinone -hydroquinone couple. In an aqueous solution at a pH below 8 we have,



(Q) (QH$_2$)

This system can be prepared by dissolving quinhydrone (a complex consisting of equimolar of Q and QH$_2$) in water. A quinhydrone electrode can be constructed by immersing a piece of platinum wire in a quinhydrone solution.

a) Derive an expression for the electrode potential of this couple in terms of E^0 and the hydrogen ion concentration.

b) When the quione-hydroquinone couple is joined to a saturated calomel electrode which acts as an anode, the e.m.f. of the cell is found to be 0.18V

   i) Give a cell notation to represent this.
   ii) Assuming the temperature to be 25°C, calculate the pH of the quinhydrone solution. (E^0 for saturated calomel electrode at 25°C = 0.2422 V)

Q.35. For the reaction

$$A + B \rightarrow C$$

the following data were obtained.

i) In the first experiment when the intitial concentrations of both A and B is 0.10 M, the observed intitial rate of formation of C is 1.0 x 10^{-4} mol min^{-1} .

ii) In the second experiment, when the initial concentrations of A and B are 0.10M and 0.30 M respectively. The initial rate is 9 0 x 10^{-4} mol min^{-1}

iii) In the third experiment when the initial concentrations of both A and B are 0.30M, the initial rate is 2 7x 10^{-3} mol min^{-1}.

a) Write done the rate law for this reaction

b) Calculate the value of specific rate constant for the reaction.

Q.36. A first order reaction,

$$A \longrightarrow B$$

has activation energy of 70 kJ mol^{-1}. When a 20% solution of A was kept at 25°C for 20 minutes, 25% decomposition took place. What would be the percentage decomposition in the same time in a 30% solution maintained at 40°C.

It is Assumed that activation energy remains constant in this range of temperature.

Q.37. The kinetics of the reaction between nitric oxide and bromine in the gaseous phase was studied. On the basis of the experimental results, the rate law was found to be,

$$\text{rate} = k\ [NO]^2\ [Br_2]$$

The probable mechanism for the reaction,

$$2\ NO + Br_2 \longrightarrow 2\ NOBr$$

was postulated as follows ·

$NO + Br_2 \longrightarrow NOBr_2$ . ... (Ist step)

$NOBr_2 + NO \longrightarrow 2\ NO\ Br$ .. .. (2nd step)

a) Why do we not prefer a simple one-step mechanism,

$$NO + NO + Br_2 \longrightarrow 2\ NOBr$$

b) What would be the rate law for the reaction if the first step in this mechanism is slow and the second step is fast ?

c) What would be the rate law if the second step is slow and first steps reaction is rapidly established with the dynamic equilibrium.

d) On the basis of experimental rate law, can the mechanism suggested in question 'a' be excluded ?

Q.38.

a) The rate laws for three different reactions are given as

Rate = k_1 [A] [B]-------------------------- (1)
Rate = k_2 $[E]^2$ ----------------------------- (2)
Rate = k_3 $[G]^2$ $[H]^2$ -----------------------(3)

Work out the units of the rate constants for three different rate equations, if the rate has the unit mol L^{-1} s^{-1}

b) For a first order reaction, A → Product, the initial concentration of the reactant A, is 'a'. Calculate the fractions of the reactant concentration remaining when the number of half-lives are 0, 1, 2, 3, 4 and 5.

c) Illustrate the concept of half-life time of a first order reaction on the basis of a graph plotted with the calculated values of the concentration of the reactants against half-life times in part 'b' of the question.

Q.39. During the study of the kinetics of the hydrolysis of ethylacetate in alkaline medium,

$$CH_3COOC_2H_5 + NaOH \rightarrow C_2H_5OH + CH_3COONa$$

The following data were obtained at 25°C.

Initial concentration of $CH_3COOC_2H_5$ (M)	0.10	0.20	0.30	0.10	0.10
Initial concentration of NaOH (M)	0 10	0 10	0.10	0.20	0.30
Rate of Reaction (mol L^{-1} s^{-1})	$10x10^{-4}$	$20x10^{-4}$	$30x10^{-4}$	$10x10^{-4}$	$10x10^{-4}$

What is the rate law and rate constant for the reaction ?

Q.40. **Step-I**

The collision theory of reaction rate is restricted primarily on the relationship between reaction rate and the number of collisions per second, among reactant molecules. In the decomposition of hydrogen iodide.

$$2HI(g) \longrightarrow H_2(g) + I_2(g)$$

5.8 x 10^{-4} moles of collision per litre per second was calculated when the concentration of HI was 10^{-3} mol L^{-1}. These collisions would correspond to a rate of reaction 5.8 x10^{-4} mol L^{-1} s^{-1}, provided all the collisions were effective. Experimentally, the rate of decomposition of hydrogen iodide was found to be 1.2x 10^{-8} mol $L^{-1}s^{-1}$

The effective collisions should be responsible to control the reaction rate. All molecules when they colloide do not lead to effective collisions. For the collision to be effective, there should be minimum kinetic energy that the molecules must possess jointly to overcome the repulsion between the electrons cloud when they colloide.

a) Why did collision theory fail to explain the reaction rate in the decomposition of hydrogen iodide

b) What should be the criteria for the molecules to cause effective collision ?

c) If 'z' be the total number of collisions that occur per second and 'f' be the fraction of the total number of collisions which are effective, then what should be the rate expression ?

d) During the collision of the molecules if the potential energy becomes smaller after the collision, what will be the fate of its kinetic energy ?

Step-II

The transition state theory of reaction rates is concerned with what actually happens during a collision of the molecules. For an effective collision, the molecules must possess minimum amount of energy called activation energy The kinetic energy is changed to potential energy at

the moment of the collision of the molecules.

The change in potential energy that takes place during the course of a reaction is shown in the form of potential energy diagram for the reaction.

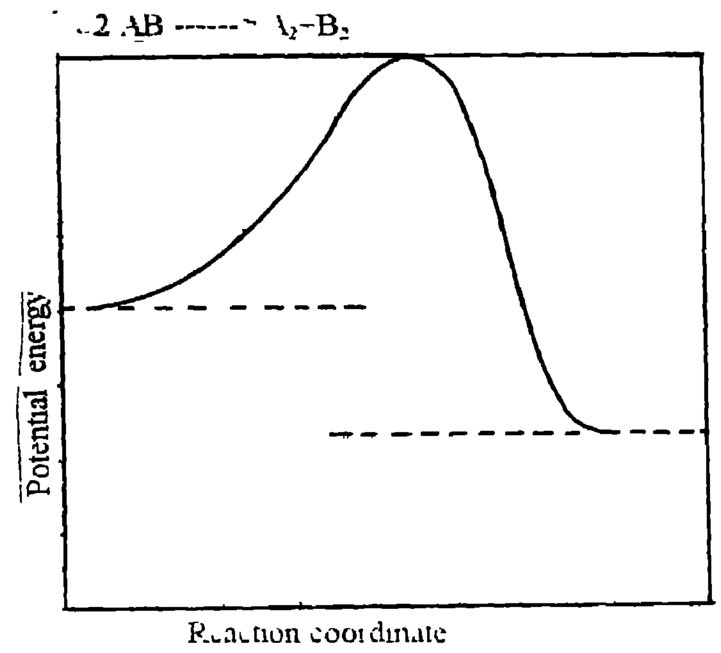


Fig.22

a) What does the reaction Coordinate on the X-axis of the potential energy diagram signify ?

b) Explain the potential energy diagram for the reaction,

$$2\,AB \longrightarrow A_2 + B_2,$$

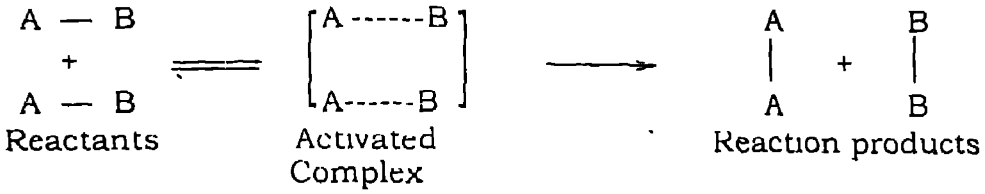
c) On the basis of potential energy diagram, explain the activation energy of the forward reaction and heat of the reaction.

d) Does the potential energy diagram shown above, represent an exothermic reaction or endothermic reaction ?

Step-III

The transition state theory views the reaction kinetics in terms of the energy and geometry of the activated complex. In the activated complex the bonds are in the process of forming and breaking to give the reactants again or to produce the reaction products. The changes that takes

place along the reaction coordinate can be represented as



Explain transition state theory of reaction rates.

Q 41. The rate constant for the reaction

$$H_2 (g) + Br_2 (g) \longrightarrow 2 HBr (g)$$

was measured at a series of temperatures. The data are given below :

Rate contant (k) 1 2x 10^{-4}, 3 5x10^{-4}; 6 8x10^{-4}; 3.8x10^{-2} ; 1.7x10^{-1} (Lmol^{-1} s^{-1})

Temperature (K) 283 302 355 393 430

Determine graphically the value of energy of activation for the reaction.

Q.43 In the Arrhenius equation for a certain reaction, the value of Arrhenius factor 'A' and energy of activation, 'Ea' are 4 x10^{13} s^{-1} and 98.6 kJ mol^{-1} respectively. If the reaction is of first order, at what temperature will its half-life be 10 minutes ?

Q.43. The gas phase decomposition of dimethyl either follows first order kinetics

$$CH_3OCH_3 (g) \longrightarrow CH_4 (g) + H_2 (g) + CO (g)$$

The reaction is carried out in a constant volume container at 500°C and has a half-life of 14.5 minutes. Initially only dimethyl ether is present at a pressure of 0 4 atm What is the total pressure of the system after 12 minutes

Q 44

a) How does photochemical reaction differ from a thermochemical reaction ?

b) How is ozone- oxygen balance in ozone layer maintained in armosphere ? The chlorofluoro carbons ($CFCl_3$, CF_2Cl_2 called

freons) have disturbed the ozone layer in stratosphere. Suggest the possible mechanism ?

Q 45 Following data are obtained for diamond crystal :

1.	Bravais structure	fcc lattice with atoms at (000), (111) and (444) associated with each lattice point
2.	Unit Cell distance	356.7 pm

a) Calculate the C-C bond distance in diamond.

b) Find the C-C-C angle in diamond.

Q.46. Enthalpies of adsorption, ($-\Delta H$ kJ mol^{-1}) for some gases on an adsorbent are given below :

H_2 = 84.0 CO = 25.0
N_2 = 21 0 CO_2 = 29.0
O_2 = 21 0 CH_2 = 21.0

Assuming desorption process to follow Arrhenius rate law i.e. k desorption $\simeq$ A exp (-E/RT), answer the following :

a) Which gas is adsorbed more strongly than others ?

b) Which gases will desorb easily ?

c) What is the effect of temperature on desorption ?

d) If energy acquired from lattice for desorption 'E' is 25 kJ mol^{-1} and vibration frequency 'A' is 10^{12} s^{-1}

   i) find the mean life time of a molecule at room temperature on the adsorbant surface

   ii) the temperature at which the rate of desorption is reduced is ....

Q.47. In chemisorption, the molecules stick to the surface as a result of formation of a bond The energy of adsorption is higher than physical

adsorption The surface coverage determines the enthalpy of adsorption.

(Hint (i) Freundlich isotherm $y=kp^{1/n}$ (physical adsorption)

ii) langmuir isotherm $\theta = \frac{p}{a + p}$ (chemisorption)]

Explain the following

a) Except in special cases, the enthalpies of adsorption for chemisorption must be negative if it is to be spontaneous.

b) The enthalpy of adsorption may change with the extent of surface coverage in some cases

c) (i) Show that at low surface coverage the langmuir isotherm corresponds to the Freundlich isotherm with n=l, (ii) Also show that at high surface coverages the langmuir equation corresponds to the Freundlich expression with n = ∞

d) What is the effect of temperature on surface coverage at different pressures ?

Q.48. The figure is a plot of 'θ' against p for Langmuir isotherm for different values of K in equation

$$\theta = \frac{\kappa p}{1 + \kappa p} \text{ when } K = \frac{k \text{ absorption}}{k \text{ desorption}}$$

Examine the figure and answer the following ·

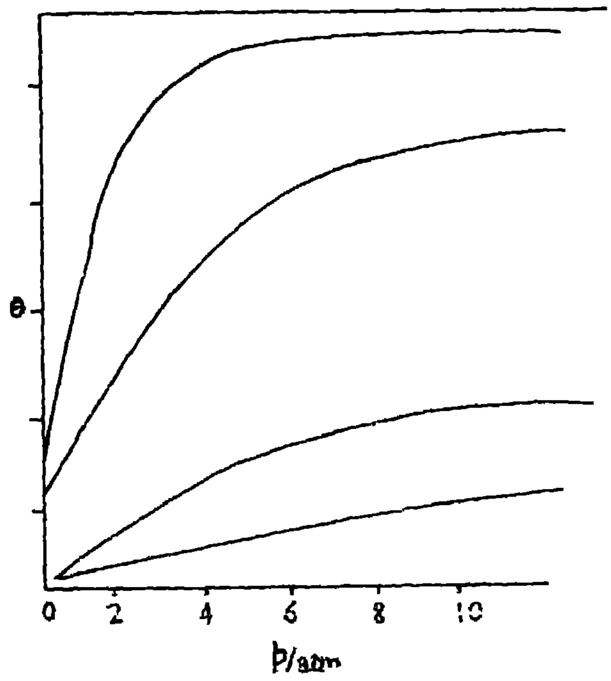


Fig. 23

a) What is the unit of K ?

b) How are these curves obtained ?

c) How can the isosteric enthalpy of adsorption (ΔH for particular surface coverage) determined ?

Q.49. Micelle is formed only above a certain concentration which is typical of a system and also at a temperature above a certain minimum value. These are referred to as critical micelle concentration (CMC) and Krafft temperature respectively The enthalpy of micelle formation in aqueous system is probably positive. The ΔS is positive for the process though the molecules are clustering. They have solubilizing property.

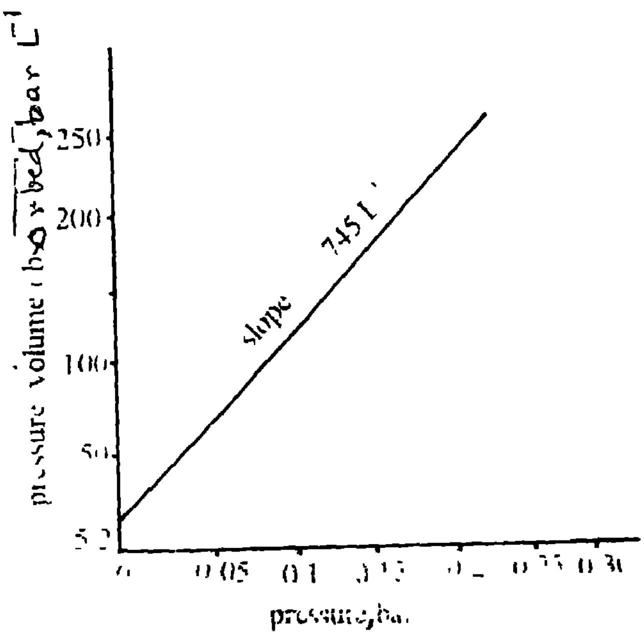
Answer the following questions on micelle on the basis of the above text

a) What is the probable cause of ΔS being positive inspite of clustering of molecules ?

b) Which end of the soap molecule or the detergent is mobile ?

c) What are the advantages of solubilizing function of micelle system ?

Q.50. The Langmuir plot for the adsorption of H_2 on copper powder at 25° C is shown in Fig 24



(Fig.24)

a) Estimate the surface area per units mass of the absorbent for which this isotherm is obtained.

[Hint : $\frac{p}{y} = \frac{a}{y_m} + \frac{p}{y_m}$

Effective area per molecule = $(V_{liq}/N)^{2/3}$

Density of liquid H_2 = 0.070 g/mL

p= Pressure, y = volume of gas adsorbed, y_m = Amount of gas needed to form a monolayer.

a = constant $\frac{k_1}{k_2}$, V_{liq} = volume of 1 mol of liquid H_2]

Q.51. The decomposition of phosphine on a glass surface as a function of time at 446°C is shown in figure'25'. The partial pressure of phosphine at time t is p and at zero time is p_o

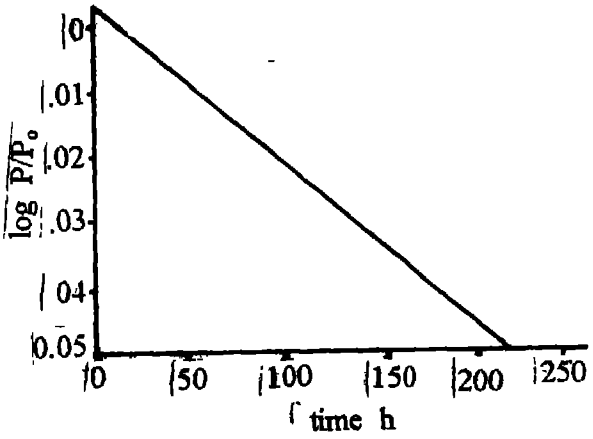


Fig.25

a) Derive rate expression for the decomposition of phosphine.

b) How can you demonstrate that this is a surface phenomenon.

Q.52. For a moderately adsorbed substance, the rate of decomposition is expected to depend upon the amount adsorbed as given by langmuir isotherm $\theta = \frac{p}{a + p}$ the decomposition might follow the rate expression:

$$-\frac{dp}{dt} = \frac{RT}{V} \frac{kp}{a + p}$$

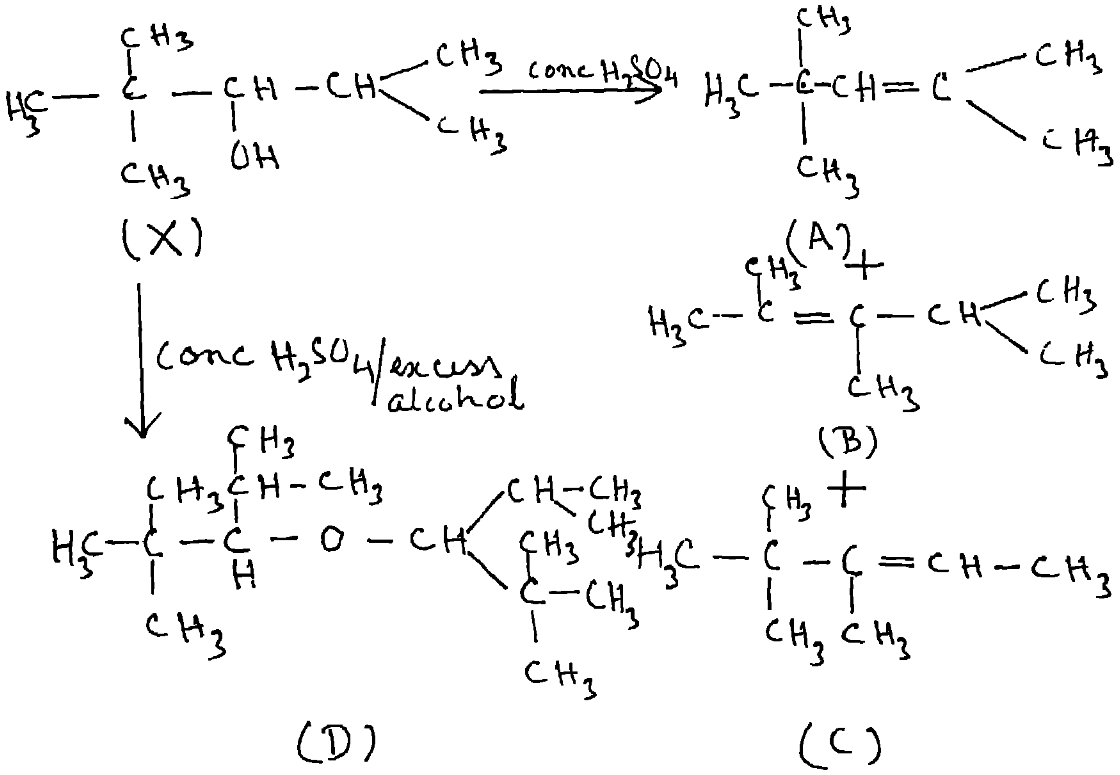
a) Derive rate expression for studying the decomposition of stibine on antimony surface.

b) When do you get a straight line from the derived expression.

c) Explain the role of 'a' in the equation.

Questions
on
Organic Chemistry
(Class - XII)

Q.1. Alcohols are an important class of organic compounds and show two types of reactions with conc H_2SO_4. If stoichiometric amounts of alcohol and sulphuric acid are taken, the product is an alkene, whereas with excess of alcohol, ethers are predominant products. the mechanism of this reaction involves protonation of alcohol molecules. Consider the following reaction and the probable products given below :



a) Arrange 'A', 'B', 'C' in order of decreasing yields, give reasons for your answer ?

b) Explain formation of 'B' and 'C' from 'X'.

c) What is the type of alcohol 'X' ?

d) Write ozonolysis products of 'A', 'B' and 'C'.

e) What will be the product if 'X' is subjected to following sequence of reactions :

$$X \xrightarrow{P/I_2} A \xrightarrow{AgNO_2} B \xrightarrow{HONO} C \xrightarrow{KOH}$$

f) What products do you get if you treat D with HI in

i) Cold condition

ii) Hot condition

g) Which out of X and D is more water soluble and why ?

h) Suggest synthesis of X using grignard reaction.

Q 2. An organic compound 'A' with molecular formula C_7H_6O on treatment with NaOH forms a mixture of B'(C_7H_8O) and'C' ($C_7H_6O_2$). On addition of HCN, 'A' forms a derivative 'D' which after hydrolysis gives 'E'. 'E' is converted into 'F' by thionly chloride followed by treatment with water. Ammonolysis of 'F' yields 'G'., which is an amino acid. A product 'H' containing exactly double No. of carbon atoms is obtained from F on treating it with sodium.

a) Draw the scheme of reactions metioned above.

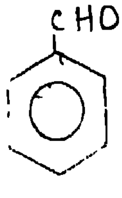
b) Write the names of compounds 'A' 'B' and 'C'.

c) Give the names of the reactions involved in the conversion of
   (i) 'A' to 'B' and 'C'
   (ii) 'F' to 'H'

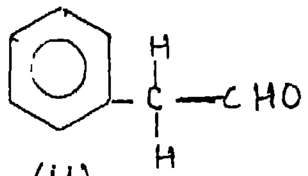
d) Identify the type of reaction involved in conversion of 'A' to 'D'.

e) What will be the product if H is heated strongly with soda lime.

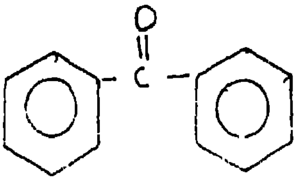
Q.3. Study the carbonyl compounds given below :



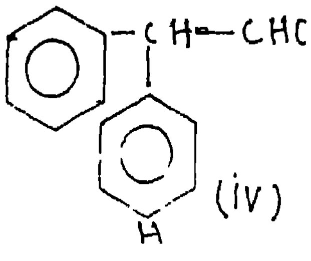
(i)



(ii)



(iii)



(iv)

a) Identify the compounds which undergo cannizzaro's reaction.

b) Suggest a method for preparing compound iii using benzene and compound i.

c) Which out of iii and iv is more prone for attack of hydroxylamine and why.

d) Suggest the structure of alkene which on ozonolysis form iii

and ıv

e) How can ııı be converted ınto ıv ?

Q.4 Whıle workıng ın a laboratory, a scientıst found that the labels of four bottles whıch contaıns

(i) butanal (ii) 2 -methyl butanal -2 (iii) methyl ethyl ketone and (ıv) propanoıc acid

were missing. He carried out the following tests for their identification.

Bottle No.	**Solubility**	**Colour formed with $K_2Cr_2O_7/H_2SO_4$**	**Other reactions**
A	insoluble in H_2O, HCl , and NaOH.	turns green	1) Changes colour of schiff's reagent. 2) forms addition product with sodium bı-sulphite. 3) No effect of litmus. 4) No reactions with sodium.
B	ınsoluble ın H_2O, HCl, and NaOH.	unaffected	1) No reaction with sodium. 2) No effect of litmus 3) positive iodoform test. 4) Adds to sodium bısulphite.
C	Soluble ın Water, dıl HCl and insoluble, ın NaOH.	turns green	1) No effect of litmus. 2) effervescence with sodıum. 3) Immediate turbidity with $ZnCl_2$ HCl.

			4) Gives a fruity smell on reaction with acetic acid and conc H_2SO_4.
D	Soluble in Water, NaOH and insoluble in dil HCl.	unaffected	1) turns blue litmus red 2) effervescence with sodium 3) No turbidity with $ZnCl_2/HCl$ 4) Gives a fruity smell on reaction with ethanol and conc H_2SO_4.

a) Match the bottle numbers 'A', 'B', 'C' and 'D' with compounds. Write the structures of all the four compounds (i), (ii), (iii), (iv) and (v).

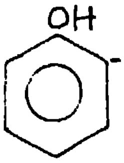
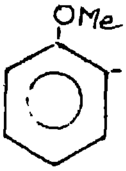
b) Which product do you get if you react contents of bottles 'C' and 'D': Write its structure.

c) When (iii) is treated with conc H_2SO_4, a mixture of two products is obtained both the components of which decolourizes $KMnO_4$. Identify the products and decide which is the major product.

Q.5. Study the table given below which gives the pKa of some disubstituted benzoic acid

No.	**Substitutuent**	**Ortho**	**meta**	**para**
1.	Me	3.91	4.27	4 37
2.	NO_2	2.17	3.49	3 43
3	F	3.27	3.87	4.14
4	Cl	2.94	3.83	3.98

5.	OMe	4.09	4 09	4.49
6.	OH	2.98	4.08	4.58
7.	NH_2	4 98	4.79	4.92

a) pKa of  -CO_2H is much lower than  -CO_2H why ?

b) from the table given which is the strongest acid and why ?

c) There is a large difference in pKa of orthonitrobenzoic acid and p-nitrobenzoic acid why ?

d) PKa of O- methoxy acid is higher than that of p-methoxy benzoic acid, why ?

Q.6. An organic compound 'A' (C_6H_7 N) gives positive carbylamine test. It reacts with $NaNO_2$ and HCl at 273 K to form compound Compound 'B' reacts with phenol to form orange dye (compound 'C')

a) Identify compounds, 'A', 'B' and 'C' giving reactions.

b) Name the reactions involved when

   (i) compound 'A' reacts with $NaNO_2$ and HCl.

   (ii) compound 'B' reacts with phenol.

c) Write resonating structures for compound B".

d) Name an indicator belonging to the class of compounds 'C'.

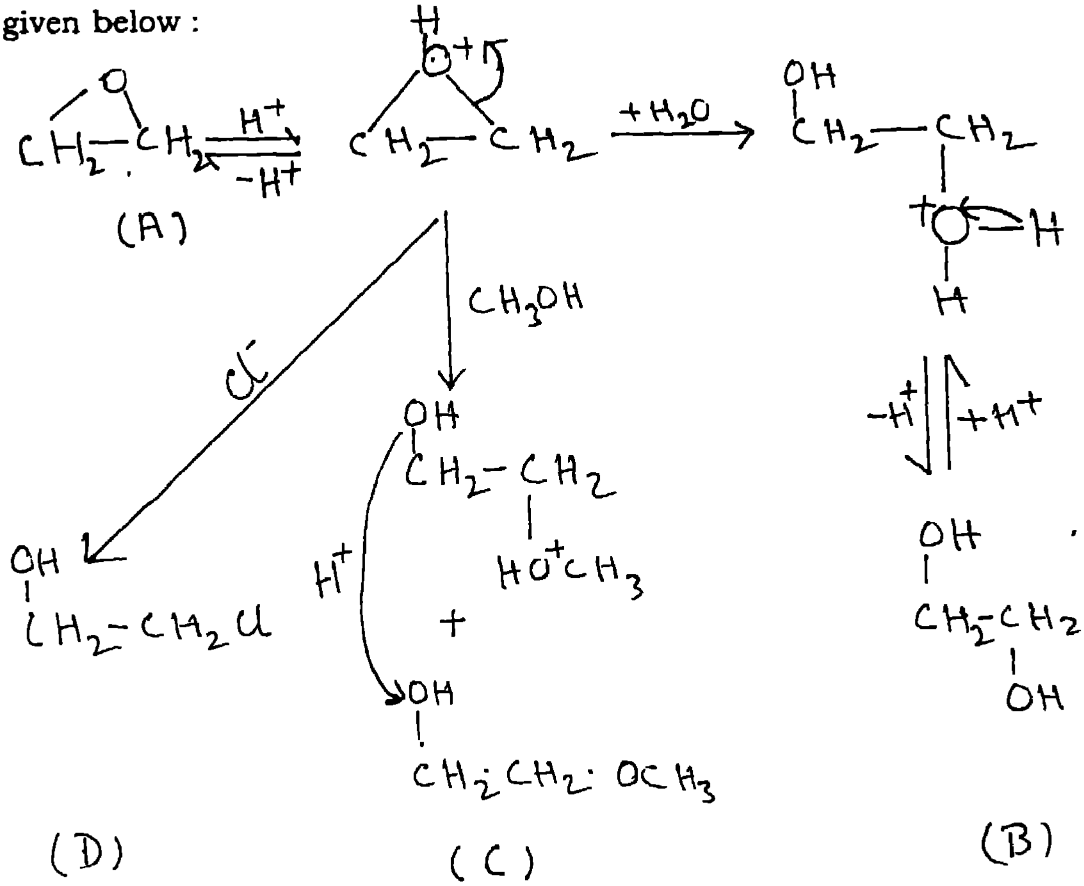
Q.7. Silver chloride dissolves in aqueous solution of compound 'A' which is basic in nature, volatile and nitrogen containing compound. Whereas copper sulphate froms deep blue solution with same compound 'A'. 0.365 g sample of the compound 'A' dissolved in aqueous HCl and treated with $NaNO_2$ solution at $0^{\circ}C$ liberated a colourless, oddourless gas whose volume is 112 mL at STP After the reaction was completed, the aqueous solution was distilled to give an organic liquid 'B' which did not contain nitrogen and which on warming with Alkali and iodine gave yellow precipitate.

a) Write down the reactions involved and deduce the molecular formula of compound 'A'

b) What are the structural formulae of the possible isomers of compound 'A'

c) Out of the possible structural isomers given under (b), which is the correct structure for compound 'A' ? Give reasons.

Q.8. Study the following sequence of reactions and answer the questions given below :



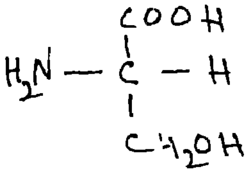
a) Give IUPAC names of 'A', 'B', 'C' and 'D'

b) Give the name of cleavage involved in this reaction.

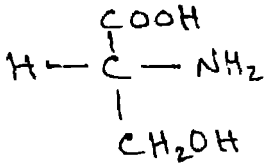
c) Give chemical equation of reaction when 'A' reacts with Grignard's reagent followed by acid hydrolysis

Q.9. Study the following pairs of compounds :

i)

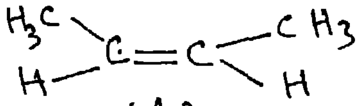


(A)

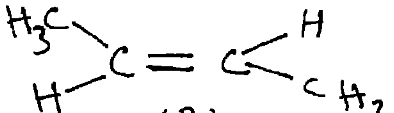


(B)

ii)

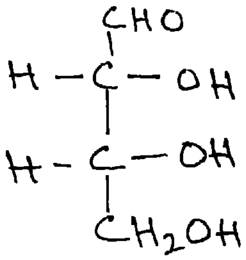


(A)

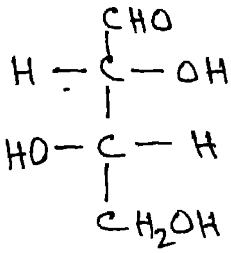


(B)

iii)

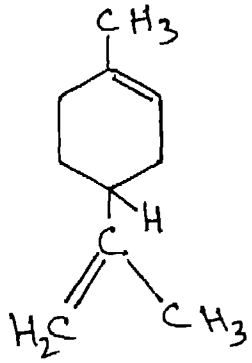


(A)

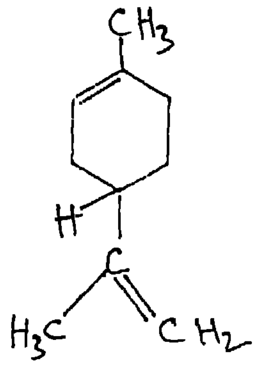


(B)

iv)



(A)



(B)

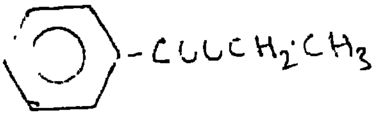
a) Arrange each pair of molecules as geometrical isomers, enantiomers or diastereisomers

b) Which compound is more stable out of the two under (ii) 'A' or (ii) 'B'.

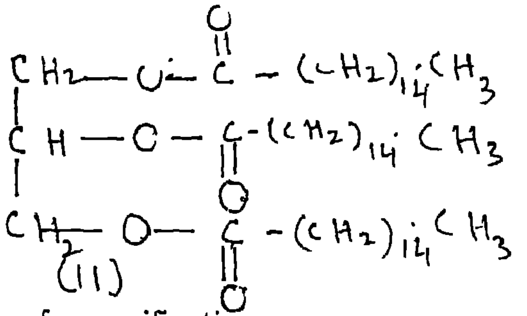
c) Compound a under (ii) when treated with Br_2 in CCl_4 decolourises the colour of Br_2 and compound 'X' is formed, give the name of compound 'X'.

Q.10. The word saponification means " the making of soap".

a) Write equations for the saponification of the following esters with aqueous NaOH.



(I)



(II)

b) Which would have a faster rate of saponification

i) Ethyl benzoate or (ii) ethyl p-nitrobenzoate ? why ?

c) Give the difference between soap and detergent.

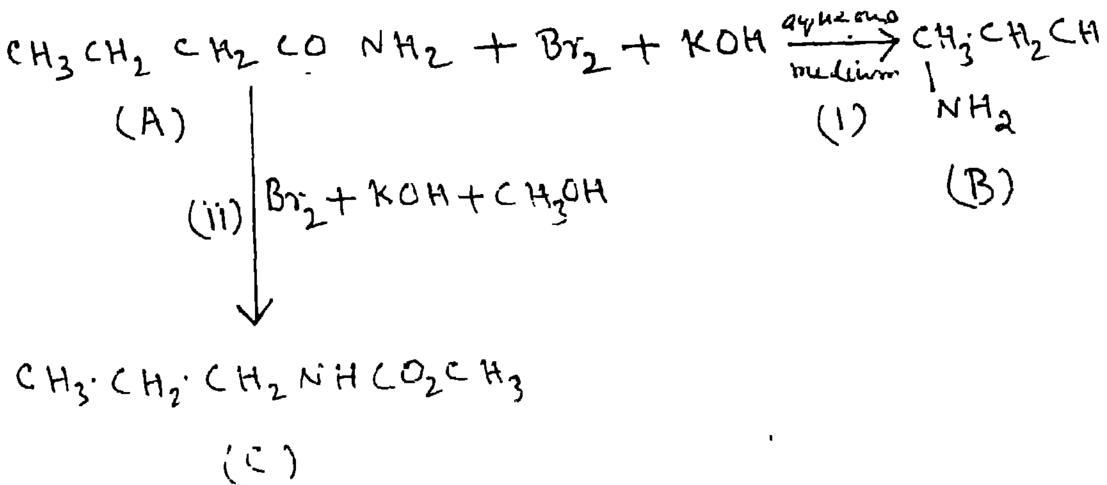
Q.11. The acetyl group if often used as a blocking group to protect an amine function for example o-amino toluene (o-toluidine) can be nitrated at carbon 3 (the carbon ortho to the nitrogen), by converting the amino group to an amide group. The overall yield is 55%. Nitrating and hydrolyzing the amide we get back an amine.

a) Write equations for these reactions.

b) What product probably constitute the remaining 45% of the yield ? Write equations for its formation.

c) Predict what would happen if o-amino toluene were treated with nitric acid directly ?

Q.12.



$$\underset{(A)}{CH_3CH_2CH_2CONH_2} + Br_2 + KOH \xrightarrow[\text{medium}]{\text{aqueous}} \underset{(B)}{CH_3CH_2\underset{NH_2}{CH}}$$

(1)

(ii) $Br_2 + KOH + CH_3OH$

$$\underset{(C)}{CH_3 \cdot CH_2 \cdot CH_2NHCO_2CH_3}$$

Study the above reactions where change of solvent causes the change in the nature of products Based on these reactions answer the following

questions.

a) Give the IUPAC names of compounds 'A' and 'B'
b) What is the mechanism of the reactions (i) and (ii) ?
c) Write down all the possible isomers of 'B' ?
d) Write down the tests for distinguishing between different isomers of 'B'.
e) How will you prepare 'A' from the corresponding acid ?
f) How would you dehydrate compound 'A' ? what is the reagent used Write the equation

Q.13. An organic compound having molecular formula $C_4H_9O(A)$ is prepared industrially from propene by the oxoprocess. It is widely used as a solvent.

a) What is the name of compound 'A' ?
b) Write down its all possible isomers.
c) Give an easy test for distinguishing between different isomers of compound 'A' :
d) Write the equation for oxoprocess ?
e) What happens when A is heated with acetic acid in presence of H_2SO_4 ? What is the reaction known as ?

Q.14. An aldehyde with no alpha hydrogen cannot undergo aldol condensation when treated with aqueous base. However if such an aldehyde is heated with conc NaOH or KOH solution the aldehyde is converted to a 1:1 mixture of carboxylate and corresponding alcohol.

a) Write down the name and equation of the reaction involved with formaldehyde
b) Give the mechanism of the above reaction with benzaldehyde.
c) Explain aldol condensation with acetaldehyde Give equation.
d) What happens when aldol is heated ? Name the product formed and give reaction involved.

Q.15. A primary alkyl bromide C_3H_7 Br 'A' was reacted with hot alcoholic KOH to give a compound 'B'. When 'B' was hydrated in presence of acid as catalyst and finally heated with cu at 573 K gave compound 'C' which on treatment with Fehling solution gave no precipitate, but on reduction with $LiAlH_4$ gave compound 'D'. The compound 'D' on treatment with Lucas reagent gave turbidity in 5 minutes. The compound 'A' reacts with benzene in presence of Anhydrous $AlCl_3$ and gives compound 'E'.

a) Give the chemical equations for conversion of 'A' to 'D'.

b) What is the name of reaction, when C_6H_6 reacts with compound 'A' in prsence of $AlCl_3$. Give equation of the reaction.

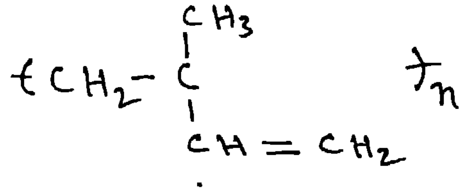
c) What happens if aqueous KOH is used instead of hot alcoholic KOH ?

d) Give the IUPAC names of the compounds 'A', 'B', 'C' and 'D'.

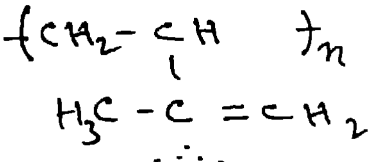
e) Write all isomeric forms of compound 'C'.

f) How do you identify the different isomers of 'C'.

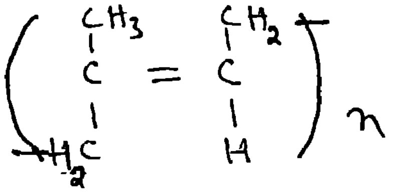
Q.16. Study the following polymers formed from isoprene by addition polymerisation under different conditions



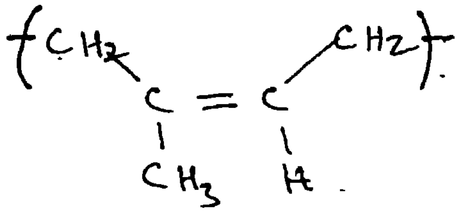
(i)



(ii)



(iii)



(iv)

a) Which of the above pair show geometrical isomerism ? classify these as cis and trans-isomers.

b) Which one of the above four polyisomers represents natural rubber.

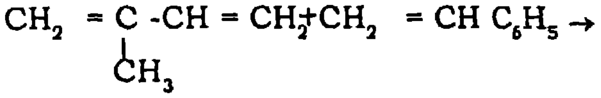
c) Which of the above four would form better fibres and shy ?

d) Which of the above four isomers have methyl group in the main chain ?

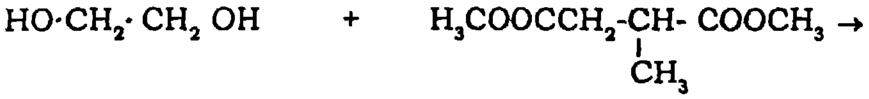
e) Name the catalyst required for production of stereo regular polymers.

Q.17. Given below are some monomer combinations for polymerisation reaction.

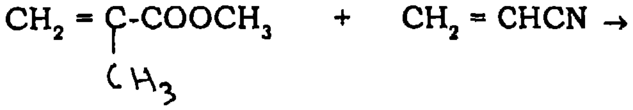
i) $CH_2 = CHCl + CH_2 = CHOC \cdot CH_3 \rightarrow$

ii) 

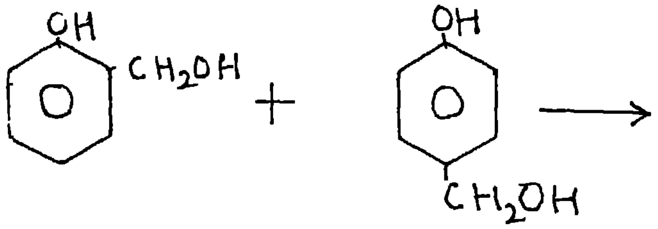
$CH_2 = \underset{CH_3}{\underset{|}{C}} -CH = CH_2 + CH_2 = CH\ C_6H_5 \rightarrow$

iii) 

$HO{\cdot}CH_2{\cdot}CH_2OH + H_3COOCCH_2\text{-}\underset{CH_3}{\underset{|}{CH}}\text{-}COOCH_3 \rightarrow$

iv) 

$CH_2 = \underset{CH_3}{\underset{|}{C}}\text{-}COOCH_3 + CH_2 = CHCN \rightarrow$

V) 

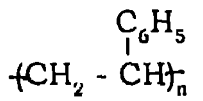
a) Complete the above reactions.

b) Classify the above reactions as chain growth or step growth polymerisations.

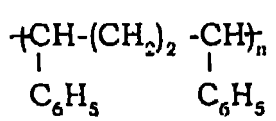
c) In which of the above reactions the unreacted monomer remains in solution till the end of the reaction.

d) Which one of the above reactions yields a thermosetting resin. What is the name of the resin ?

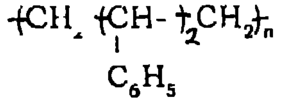
Q.18. Styrene on polymeri-station can possibly form the following three polymers :

i) 

$\left(CH_2 - \overset{C_6H_5}{\overset{|}{CH}}\right)_n$

ii) 

$\left(\underset{C_6H_5}{\underset{|}{CH}}\text{-}(CH_2)_2\text{-}\underset{C_6H_5}{\underset{|}{CH}}\right)_n$

iii) 

$\left(CH_2 \left(\underset{C_6H_5}{\underset{|}{CH}}\text{-}\right)_2 CH_2\right)_n$

a) Which one of the above three results from head to tail addition ?

b) Which one of the above three has least free energy of formation ?

c) Why head to tail addition is preferred over head to head or tail to tail addition ?

d) Polystyrene is a thermoplastic or thermosetting resin ? Give reasons for this classification

e) Between polythene and polystyrene which one likely to form better fibres ? Why ?

Q.19. We know that ethylene glycol on condensation with three isomers of phathalic acids viz.ortho, meta (isophthalic acid) and para phthalic acid (terephthalic acid), give three different condensation polymers. Based on this answer the following :

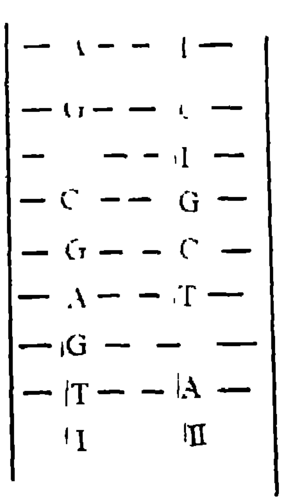
a) Draw the structure of the three polymers and number these as (i), (ii) and (iii) respectively

b) Which one of these three shall prove to be a good fibre with high tensile strength and why ?

c) Give the commercial name of the polymers formed from terephathalic acid and phthalic acid.

d) Why ester of phthalic acid is preferred for use than free acid in commercial manufacture of these polymers

Q.20 Study the damaged sequence of a portion of nucleic acid having two complementary strands I and II as given below :



a) What bases are required in strand I and strand II respectively, to repair it ?

b) Is it a portion of DNA or RNA

c) Draw the sequences of two daughter strands resulting form its replication and mark the two as III and IV respectively.

d) How are strands II and III related ?

e) Write the sequence of m-RNA resulting from transcription of Strand I.

f) Name the force which is mainly responsible for complementary of bases.

Q.21. Following is a segment of messenger -RNA

5' GC U U C U A A C U U U A C U 3'

a) Write the sequence of DNA strand from which it has possibly been formed making the 3' and 5' termini. What is this process known as ?

b) Write the structure of DNA duplex resulting from the strand as obtained under 'a'.

c) If the peptide obtained from the above m-RNA is alanine serine as

paragine- phenylalamine threonine write down the codons for each of these amino acids. Name this process

d) If the peptide formed is serine threonine- phenylalanine asparagine, write down the m-RNA composition from which it would have been formed

e) If a single base is somehow changed in a DNA sequence, shall it affect the nature of protein formed ? What is this type of phenomenon known as ?

Q.22. We know that DNA molecules exist in the form of double helix. On heating the helix unwinds. The temperature at which the two strands separate from each other is called as the "melting temperature ". The individual DNA molecules change from rigid rods to crumpled balls as they melt.

a) The viscosity (resistance to flow) of DNA solution should increase or decrease on melting ?

b) A DNA helix having 1000 G C. base pairs and 600 A-T base pairs has higher melting temperature as compared to another helix having 1000 A-T base pairs and 600 G-C base pairs. Explain why ?

c) The entropy of the DNA solution increases or decreases at the melting temperature.

d) The crystallinity of the system is more or less at the melting temperature

e) Two DNA samples have melting temperature 60°C and 68°C. If one of these which melt at 60°C has 1000 base pairs, the other one will have more or less base pairs than 1000 ?

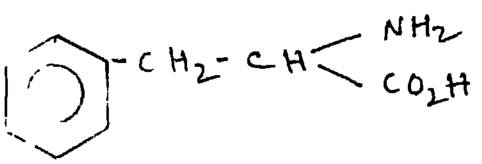
f) If a DNA solution is heated upto its melting temperature and again cooled, do you expect any structural change in DNA finally.

Q.23. A biologically important compound 'A' with molecular formula $C_{12}H_{22}O_{11}$ is optically active but does not reduce ammoniacal silver nitrate. On hydrolysis with dil HCl, two optically active isomeric products 'B' and 'C' (molecular formula $C_6H_{12}O_6$) are obtained. 'B' can be oxidised to a

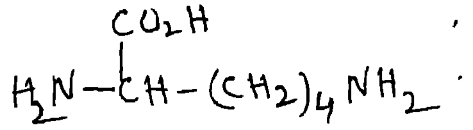
compound having same number of carbon atoms but 'C' cannot be oxidised. But they form same product with phenyl hydrazine. Both 'B' and 'C' occur in two crystalline, isomeric forms, which have different physical properties and optical rotations When equal amount of the two crystalline forms of 'B' (b$_1$ and b$_2$) are mixed in water a substantial change in optical rotation is observed after same time. A linear polymer of b$_1$ is edible and readily digestible by human being but that of b$_2$ is not.

a) Identify, 'A', 'B' and 'C'
b) How are 'B' and 'C' linked in 'A'. What is this linkage called ?
c) Why does optical rotation of b$_1$ and b$_2$ change on dissolving in water. What is this phenomenon known as ?
d) What type of isomers are b$_1$ and b$_2$?
e) Why are 'A', 'B', 'C', 'b'$_1$ and 'b'$_2$ optically active ?

Q.24. Study the amino acids 'A' to 'D' given below :

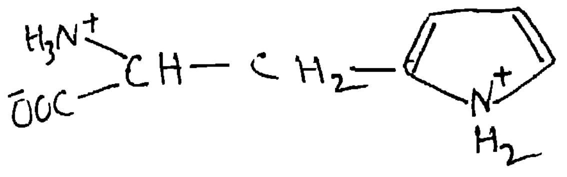


(A)

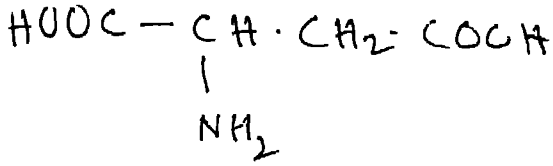


$H_2N-\overset{CO_2H}{\overset{|}{C}}H-(CH_2)_4NH_2$

(B)



(C)



$HOOC-\underset{NH_2}{\underset{|}{C}}H\cdot CH_2\cdot COOH$

(D)

a) Which amino acid has more hydrophobic side chain?

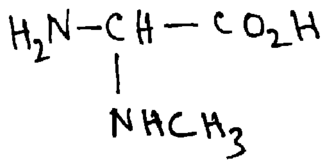
b) Write the structure of amino acid 'B' at pH < 4.

c) Write the structure of 'D' at PH > 10.

d) Would 'C' in this form migrate to anode or cathode, or not migrate at all?

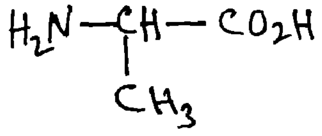
e) Would this form of C predominate at PH = 10 or PH = 4

Q 25. Consider the amino acids a_1, a_2 and a_3 given below:



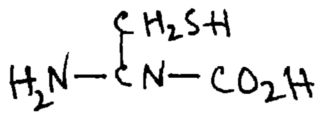
$H_2N-\underset{NHCH_3}{\underset{|}{CH}}-CO_2H$

a_1



$H_2N-\underset{CH_3}{\underset{|}{CH}}-CO_2H$

a_2



$H_2N-\overset{CH_2SH}{\overset{|}{C}}N-CO_2H$

a_3

a) Write down the various combinations of tripeptides formed from the amino acids a_1, a_2 and a_3. Indicate 'N' terminal and 'C' terminal amino acids.

b) Choose the tripeptide $a_1 - a_2 - a_3$. Write its structure at pH > 11.

c) What describes the primary structure of a peptide ?

Q 26. We know that energy changes are associated with glucose metabolism as mentioned below:

i) glyceraldehyde, 1, 3- phosphate + NAD ⟶ 1, 3-diphosphoglycerate + NADH + H^+ ; ΔG = 1500 cal/mol.

ii) ADP + 1, 3- diphosphoglycerate ⟶ 3-phosphoglycerate + ATP; ΔG = -4500 cal/mol.

iii) 3-phosphoglycerate ⟶ 2--phosphoglycerate; ΔG =1060 cal/mol.

iv) 2-phosphoglycerate ⟶ 2-phosphoenolpyruvate; ΔG = 440 cal/mol.

v) ADP + phosphoendlpyruvate ⟶ ATP + Pyruvate; ΔG = -7500 cal/mol.

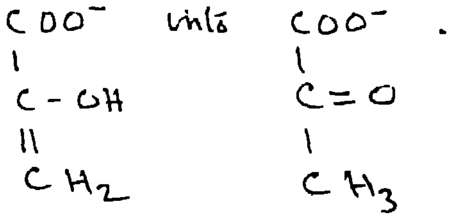
a) Which of the reactions are possible as isolated reactions?

b) What will be overall energy change for conversion of glyceraldehyde

to get 3 moles of pyruvate

c) Phosphorylation of ADP is endothermic but still reaction (ii) is exothermic why ?

d) Conversion of enolpyruvate pyruvate involves a phenomenon, what is this phenomenon ?



$$\begin{array}{c} COO^- \\ | \\ C-OH \\ \| \\ CH_2 \end{array} \quad \text{into} \quad \begin{array}{c} COO^- \\ | \\ C=O \\ | \\ CH_3 \end{array}$$

e) How can glyceraldehyde be converted to glyceric acid in an isolated reaction ?

Q 27. A few carbohydrates are given below:

Glucose
Fructose
Sucrose
Maltose
Lactose
Cellulose
Starch

a) Mark the reducing sugars and explain why they are reducing ?

b) Classify them as mono, di or polysaccharides ?

c) Find the sugars which show mutarotation.

d) What enzymes are used to hydrolyse sucrose into glucose and fructose ?

e) An aqueous solution of starch on boiling forms a colloidal solution, why ?

Q 28. Compound 'X' obtained from an extract of a shrub can be hydrolysed to give a straight chain primary alcohol 'Y' with 26 carbons and a straight chain carboxylic acid 'Z' with 28 carbon atoms.

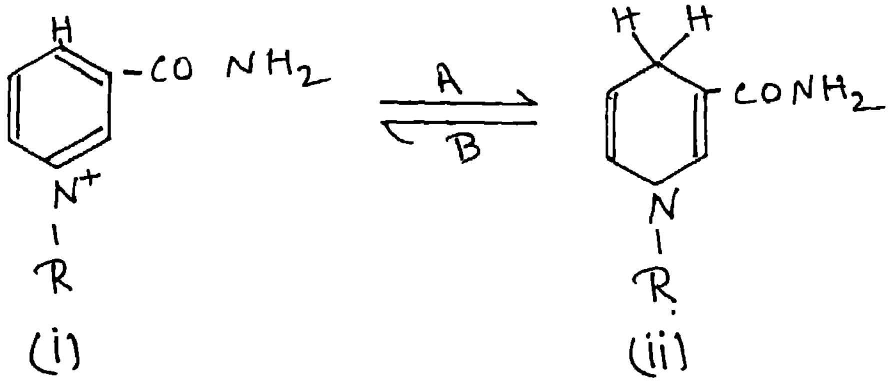
a) Write the structure of this compound.

b) Will this compound be water soluble, if not, why?

c) If both this products 'Y' and 'Z' are used in synthesising a hypothetical phosphoglyceride, what will be the structure of this phosphoglyceride.

d) What happens when electric current is passed through an alkaline solution of 'Z'.

Q 29 Study the structures (i) and (ii) given below



(Hint: an enzyme NAD $^+$ undergoing a reversible change on the surface of a substract).

a) In forward reaction 'A', what is 'i' abstracting from the substract and transferring to form ii ?

b) What type of reactions are the forward 'A' and the backward 'B' ?

c) In reactions 'A' and 'B' whether electrons are lost or gained ?

d) Name the enzyme (ii) ?

e) The enzyme NAD $^+$ plays an important role in alcoholic fermentation. Write the chemical change involved in this specific step.

Q 30. Through the following process taking place in a plant cell, water + carbon dioxide $\xrightarrow[\text{solar energy}]{h\nu}$ organic molecules + heat + oxygen and ATP, a large number of important bio-molecules are synthesised. Based on this answer the following:

a) What type of energy changes are involved in this process?

b) Name the primary product formed in the process.

c) Name the process.

d) Name some important biomolecules synthesised by the cells

utilizing the energy acquired in the above process.

e) Does our present knowledge of the mechanism of the above process support the following series of reactions.

$CO_2 \xrightarrow{h\nu}$ reduced carbon + O_2

6 reduced carbons + $6H_2O \longrightarrow C_6H_{12}O_6$

(f) Does our present knowledge support the following hypothesis?

$$2H_2O + 2A \xrightarrow{h\nu} 2AH_2 + O_2$$

If it supports the hypothesis what is the nature of 'A'?

(g) In reaction:

$$6CO_2 + 6H_2O \xrightarrow{h\nu} C_6H_{12}O_6 + 6O_2$$

If oxygen of CO_2 is labelled with an isotope of oxygen O^{18}, would it appear in the O_2 produced? Give reason for your answer.

(h) Is water an electron donor or acceptor in the above mentioned process ? If H_2S is used in place of water what would be the nature of the products ?

Q 31. Given below are two reactions which are coupled with respect to Gibb's free energy,

Creatine phosphate + E = EP + Creatine (i)

EP + ADP = ATP + E (ii)

Where 'E' is an enzyme and 'EP' is phosphorylated enzyme. The free energies of the following reactions are,

Creatine phosphate + H_2O = Creatine + P.. ΔG^0 = -43.5 kJ/mol. (iii)

ADP + P = ATP + H_2O .... ΔG^0 = 39.8kJ/mol (iv)

Based on this information answer the following questions.

a) Write down the final coupled reaction for (i) and (ii).

b) Calculate the free energy for the final coupled reaction.

c) What is the role of enzyme 'E'.

d) In which molecule the energy is finally conserved and what is the intermediate step through which it is transferred ?

(e) Which of the two reaction (iii) and (iv) is thermodynamically favoured ?

(f) Would the final coupled reaction occur spontaneously. If yes why ?

Q 32. The Gibb's free energies [$\Delta G(\text{kJ mol}^{-1})$] of some reactions have been estimated and the data is given below:

	Reaction	$\Delta G(\text{kJ mol}^{-1})$
i)	Acetyl phosphate + H_2O = Acetate + P	-43.1
ii)	Glucose-6-phosphate + H_2O = Glucose	-12.6
iii)	Glycerol - 1-phosphate + H_2O = Glycerol + P	-9.2
iv)	Arginine phosphate + H_2O = Arginine + P	-29.3
v)	ADP + P = ATP + H_2O	-39.8
vi)	ATP + H_2O = ADP + P	-39.8
vii)	ADP + H_2O = AMP + P	-36.8
viii)	AMP + H_2O = Adenosine + P	-12.6

(P = Inorganic phosphate)

Based on this data solve the given questions

a) Combining each of the reactions (i), (ii), (iii) and (iv) with reaction (v), calculate the resultant free energy (ΔG in kJ mol^{-1}) of each of the coupled reactions.

b) Out of the four coupled reactions worked out under (a) which are thermodynamically favoured and which are not . Give reason for your answer.

c) Can the combination of reactions (v) and (vi) be called a coupled reaction. What is the resultant ΔG for this combination ?

d) Calculate ΔG for :

ATP + $2H_2O$ = AMP + PP

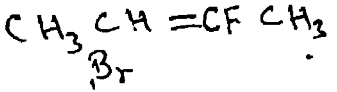
e) Calculate ΔG for :

ATP + $3H_2O$ = A + PPP

f) Calculate ΔG for :

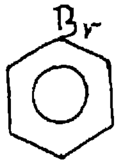
ADP + $2H_2O$ = A + PP

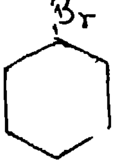
Q 33. Study the structural formulae of halogen substituted compounds listed below:

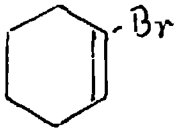
i) 

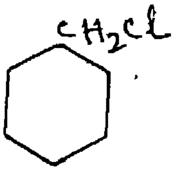
$CH_3CH(Br)=CFCH_3$

ii) $(CH_3)_3CBr$

iii) 

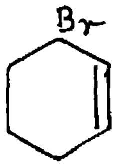
iv) 

(v) 

vi) 

vii) $CF_3CHClBr$

viii) $CH_2=CH\,CH_2Br$

ix) 

a) Classify them as allyl, vinyl, alkyl and aryl halides,

b) Which one of them is used as anesthetic agent? What is its trade name?

c) Draw most stable structure of the compound (iv).

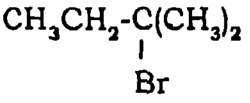
d) Which compound is more reactive and why?

e) Write the common and IUPAC names of the compound (viii).

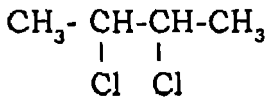
f) Write the structure of isobutyric formic anhydride and give its IUPAC name.

Q 34. Some alkyl halides may be prepared as shown in the following reactions.

i) $(CH_3)CH \xrightarrow[\text{or light}]{Br_2\text{ heated}} (CH_3)_3CBr$

ii) $CH_3CH=C(CH_3)_2 \xrightarrow{HBr}$ 

$CH_3CH_2\text{-}C(Br)(CH_3)_2$

iii) $CH_3CH=CHCH_3 \xrightarrow{Cl_2}$ 

$CH_3\text{-}CH(Cl)\text{-}CH(Cl)\text{-}CH_3$

iv) $CH_2=CH\,CH_2Cl \xrightarrow{NaI} CH_2=CH\text{-}CH_2\,I$

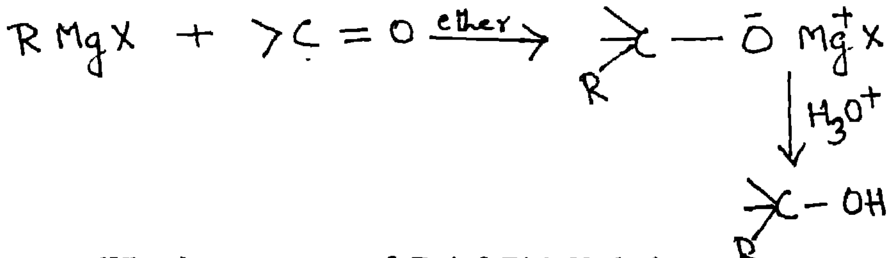
a) Identify the species or intermediate involved in the reactions (i) and (iii).

b) What mechanisms are involved in reactions. (ii), (iii) and (iv).

c) What stabilizing effects i e inductive, resonance or any other effect is/are operating in reaction (iv)

d) Draw various stereoisomers of the product of reaction (iii).

Q 35. Alcohols may be synthesised by the reaction of carbonyl compounds (aldehydes, ketones, esters, acid chlorides) with a grignard reagent.



a) Which property of R (of RMgX) helps it to make a bond with carbonyl carbon ? Show this bond formation by curved arrows.

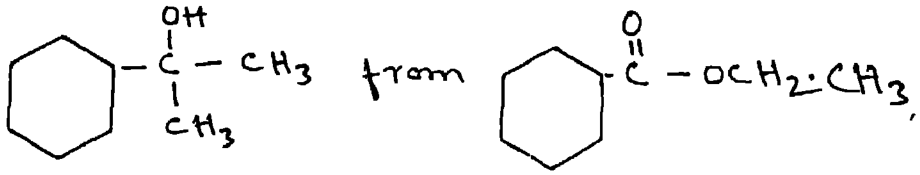
b) Show how can you prepare t-butyl alcohol by using CH_3MgBr and an acid chloride or an ester.

c) Give grignard synthesis to prepare the following alcohols from the indicated starting material.

   i) 3-octanol from hexanal.

   ii) 1-cyclohexylethanol from acetaldehyde.

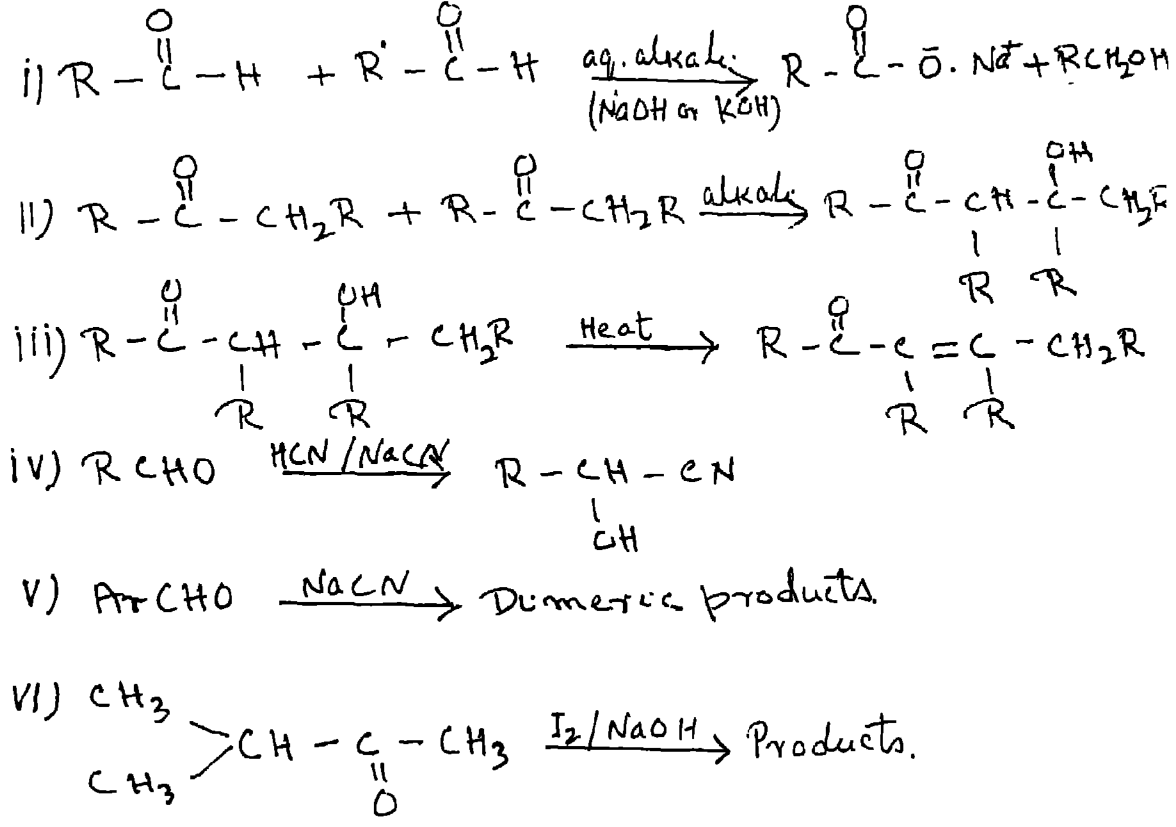
   iii)



d) Give IUPAC name of alcohol in C-iii.

e) Apply grignard synthesis for preparation of diphenyl methanol.

Q 36.



$$\text{i)}\ R-\overset{O}{\overset{\|}{C}}-H + R'-\overset{O}{\overset{\|}{C}}-H \xrightarrow[\text{(NaOH or KOH)}]{\text{aq. alkali}} R-\overset{O}{\overset{\|}{C}}-\bar{O}\cdot Na^{+} + RCH_2OH$$

$$\text{ii)}\ R-\overset{O}{\overset{\|}{C}}-CH_2R + R-\overset{O}{\overset{\|}{C}}-CH_2R \xrightarrow{\text{alkali}} R-\overset{O}{\overset{\|}{C}}-\underset{R}{\underset{|}{CH}}-\overset{OH}{\overset{|}{\underset{R}{\underset{|}{C}}}}-CH_2R$$

$$\text{iii)}\ R-\overset{O}{\overset{\|}{C}}-\underset{R}{\underset{|}{CH}}-\overset{OH}{\overset{|}{\underset{R}{\underset{|}{C}}}}-CH_2R \xrightarrow{\text{Heat}} R-\overset{O}{\overset{\|}{C}}-\underset{R}{\underset{|}{C}}=\underset{R}{\underset{|}{C}}-CH_2R$$

$$\text{iv)}\ RCHO \xrightarrow{HCN/NaCN} R-\underset{OH}{\underset{|}{CH}}-CN$$

$$\text{V)}\ ArCHO \xrightarrow{NaCN} \text{Dimeric products.}$$

$$\text{VI)}\ \begin{matrix}CH_3\\CH_3\end{matrix}\!\!>CH-\underset{O}{\underset{\|}{C}}-CH_3 \xrightarrow{I_2/NaOH} \text{Products.}$$

a) Identify these reactions which are well known, name reactions/ condensation reactions.

b) Identify the products of reaction (i) if $R \equiv C_6H_5$ and $R' \equiv H$

c) What is the structure of the dimeric product in (V)

d) Write the products in (vi) and give their IUPAC names.

Q 37. A compound 'A' ($C_6H_2O_2$) on reduction with $LiAlH_4$ yielded two compound, 'B' and 'C'. The compound 'B' on oxidation gave 'D' which on treatment with aqueous alkali and subsequent heating furnished 'E'. 'E' on catalytic hydrogenation gave 'D'. The compound 'D' was oxidised further to give 'F' which was found to be a monobasic acid (molecular wt=60).

a) Name some functional groups which can be reduced by $LiAlH_4$.

b) Write the real species of the $LiAlH_4$ reagent which is responsible for reduction.

c) Can you name any other reagent which provides the same species?

d) Draw the structures of 'A', 'B', 'C', 'D' and 'E'.

e) Write IUPAC name of 'A'.

Q 38. Study the inter conversion of acid derivatives

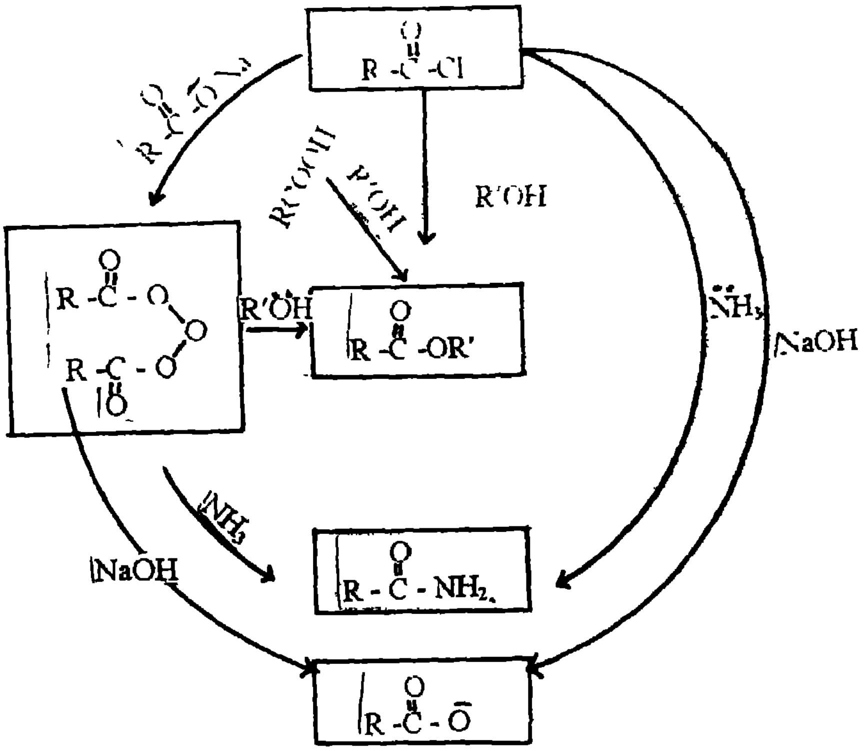


Fig. 26

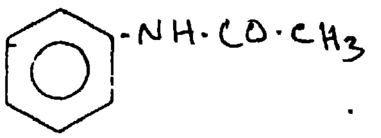
a) Give the preparation of methylpropionate using methanol and the following appropriate compounds

i) Acid chloride

ii) Carboxylic acid anhydride

iii) Carboxylic acid

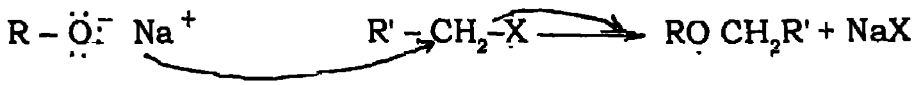
b) Give two sets of reactants for the preparation of acetanilide



c) Write reaction for the preparation of butanoic ethanoic anhydride

d) Why are acid chlorides most reactive acid derivatives.

Q 39. We know that Williamson synthesis is a reaction for the preparation of ethers. The reaction involves an attack of an alkoxide on an unhindered alkyl halide.



$$R-\ddot{O}:^- \; Na^+ \qquad R'-CH_2-X \longrightarrow RO\,CH_2R' + NaX$$

a) Mention the class of alkyl halides which are used in the above synthesis ?

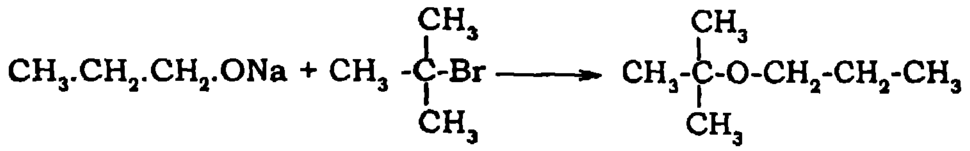
b) Whether the above reaction is nucleophilic or electrophilic.

c) What kind of reaction would take place in case the alkyl halide does not correspond to the proper structural features as shown above ?

d) Starting from isopropyl alcohol, show how would you synthesise butylisopropyl ether

e) (i) Why the following reaction is a poor method for the synthesis of t-butyl propyl ether ?

(ii) What would be the major product from this reaction ?



$$CH_3.CH_2.CH_2.ONa + CH_3\text{-}\underset{CH_3}{\overset{CH_3}{\underset{|}{\overset{|}{C}}}}\text{-}Br \longrightarrow CH_3\text{-}\underset{CH_3}{\overset{CH_3}{\underset{|}{\overset{|}{C}}}}\text{-}O\text{-}CH_2\text{-}CH_2\text{-}CH_3$$

f) Write a better method of synthesis of t-butyl propyl ether than the poor method mentioned above (e-i).

Q 40. An organic compound 'A' on treatment with acetic acid in presence of sulphuric acid produces an ester 'B'. 'A' on mild oxidation gives 'C'. 'C' with 50% KOH followed by acidification with dil HCl generates 'A' and 'D'. 'D' with PCl_5 followed by reaction with NH_3 gives 'E', which on dehydration produces hydrocyanic acid

a) Identify 'A' to 'E'.

b) Give the name of the principal reactions

Q 41. Study the table given below:

Carboxylic acid	K_a	mp	solubility
HCOOH	1.8×10^{-4}	8°C	∞
CH_3COOH	1.8×10^{-5}	17°C	∞
CH_3CH_2COOH	1.3×10^{-5}	21°C	∞
$CH_3(CH_2)_2COOH$	1.5×10^{-5}	27°C	∞
$CH_3(CH_2)_3COOH$	1.5×10^{-5}	-35° C	4.97

a) Compare the acidity of formic acid and acetic acid based on their K_a value.

b) Moving from HCOOH to CH_3COOH, the value of K_a changes remarkably but after that there is not much change in K_a value. Explain Why ?

c) What conclusion is drawn from the data of m p. about the structure of acids. Explain with reason.

d) $CH_3(CH_2)_3COOH$ shows least solubility in water among the given acids. When a strong acid is added to it. It almost becomes insoluble, why?

Q 42. To compensate for lack of natural rubber Germany produced a polymer. The structure of a segment can be given as:

$(-CH_2-CH_2-CH = CH-CH_2-CH_2-CH = CH-CH_2-CH_2-CH = CH-)$

a) What is the name given to the rubber above ?

b) What are its monomers ?

c) Does this nomomers exhibit cis-trans isomerism ?

d) What kind of polymer it will be called based on its properties ?

e) What happens when the monomer unit is treated with styrene ? Name the resulting product.

Q 43. Dehydrohalogenation of 2-Chlorobutane is done by treating it with KOH in ethanol. The elimination reaction takes place.

(Hint. Saytzeff rule)

a) What are the two isomers possible when dehydrohalogenation takes place

b) Out of two isomer formed which will have maximum yield and why?

c) Which isomer will exhibit geometrical isomerism. Write the structure also.

d) Will the compound 2-chlorobutane be optically active. Give reason.

Q 44. When compound 'A' ($C_4H_6O_4$) is heated, compound 'B' ($C_4H_4O_3$) is formed. When 'A' is treated with an excess of methanol and trace of

sulphuric acid, compound 'C' $C_6H_{10}O_4$ is obtained On treatment with $LiAlH_4$ followed by hydrolysis compound 'A' produces Compound D'($C_4H_{10}O_2$). 'A' can also form polymer 'E' with 'D'

a) identify 'A', 'B', 'C' 'D', and 'E'. Write reactions and mention their IUPAC names.

b) What is the other positional isomer of compound 'A'.

c) What will happen when positional isomer of 'A' is heated?

d) Write the common name of compound 'A'.

e) What would you say about the optical activity of Compound 'A'.

Q 45. Suppose you are given an unknown liquid and told that it is either t-butyl alcohol or n-butyl alcohol You are also told that when a few drops of unknown liquid are shaken with dilute potassium permanganate the purple colour of the MnO_4^- disappears and a brown precipitate forms. It also give immediate turbidity when treated with $ZnCl_2$/dil HCl.

a) Write the structure of two above given alcohols and mention the degree of carbon to which functional group is attached.

b) Which alcohol will be oxidised by potassium permanganate and why ?

c) Write the functional isomers of the above given alcohols.

d) Write the reaction for oxidation and also write the functional isomer of the product formed. Write down its IUPAC name.

e) Which alcohol of the above two is more acidic and why ?

f) What happens when the given two isomeric alcohols are dehydrated at high temperature?

g) Which isomeric ether is used as anesthetic.

h) Why anesthesiologist avoid using the compound mentioned in 'g'?

Q 46. Polymer are giant molecule composed of repetitive unit of monomer. Vinyl acetate is also a monomer which could be used for making a polymer known as polyvinyl acetate.

a) Write part of the structure of a molecule of polyvinyl acetate.
b) Write the mechanism of polymerisation.
c) Is it a copolymer or homopolymer ?
d) What type of additional bond exist between the chains of polymer
e) Due to existence of additional bond between the chain, will the polymer be amorphous and soft or hard and crystalline ?
f) Name a commonly known catalyst used to control the stereochemistry of polymer.
g) Write an important use of this polymer.

Q 47. A mixture of two aromatic compounds 'A' and 'B' was separated by dissolving in $CHCl_3$ followed by extraction with KOH solution. The organic layer containing 'A' when heated with alcoholic solution of KOH produces 'C'(C_7H_5N) associated with unpleasant odour. The alkaline aqueous layer on the other hand when treated with chloroform followed by acidification gave a mixture of two isomeric compounds 'D' and 'E' of formula $C_7H_6O_2$.

a) What conclusion do you draw about the nature of compound 'A' and 'B' based on their solubility in different solvent.
b) Identify 'A', 'B', 'C', 'D', 'E' and write their names.
c) Name the reaction by which 'A' is converted to 'C' and 'B' is converted to 'D'.
d) If an electron donating group is attached to the functional group of compound 'A'. What happens to the acidity or basicity ?
e) Which of the isomer ('C' or 'D') is used to prepare an important antipyretic Name the compound ?

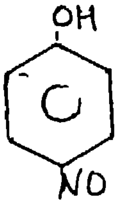
Q 48. Phenols are very sensitive towards electrophilic reagent The great nuclear reactivity has the disadvantage of causing many reactions to be difficult to control. For example when phenol is treated with excess of Br_2 it forms 2, 4, 6 tribromophenol.

a) In order to prepare p-bromophenol what condition should be choosen ? Write the reaction also.
b) If polar solvent like H_2O is taken in the reaction controlled

bromination of phenol it does not take place why ?

c) How would you convert phenol to 2, 6-dibromo 4-nitrophenol.

d) Write the product formed and its IUPAC name when phenol is treated with 2-methyl propene for alkylation.

e) 

is made when phenol is treated with nitrous acid, the compound shows tautomerism. Write the tautomer of this compound and identify the functional group.

49. If the nucleus is very electron rich, it can be coupled with diazonium salt. The compound so formed are also known as azo-compounds. The attacking species are a positive diazonium cation and a electron rich aromatic group. The azo-compound are preferred to be para.

a) When benzene diazonium chloride is treated with NN-Dimethyl aniline. What is the common name of the dye so formed?

b) Write down the mechanism of the reaction?

c) Why the azo-compound so formed are para?

d) When phenol is coupled with diazonium salt the pH of the medium is carefully controlled. For this process usually salt of weak acid is taken, why ?

Questions
on
Inorganic Chemistry
(Class - XII)

Q 1. (a) Draw plausible structures of the following, assuming that the central atom is attached to the adjacent atoms on the left and the right

- i) $H_2N_2O_2$
- ii) NSF_3
- iii) $FClO_3$
- iv) O_2NF
- (b) Draw an alternative plausible structure of each of the above molecule, if any.

Q 2. Consider the following diatomic molecules (ions) C_2, N_2^+, B_2^-, O_2^{2-} and F_2^-

- (a) Arrange them in order of increasing bond order.
- (b) Among them pick out those having same number of unpaired electrons.
- (c) In each of them what is the number of nodes in the highest energy molecular orbital which is occupied by electron(s).

Q 3. Nitrogen and phosphorus are capable of forming various halides and haloanions such as NF_3, PF_3, NF_4^+, PF_4^+, NF_4^-, NF_5 and PF_5.

- (a) Some of the above species are not formed. Identify them and explain why are they not formed ?
- (b) What are the types of hybridization in the species which are capable of existing ?
- (c) Identify the diamagnetic species among those which are capable of existing.
- (d) Identify the polar molecules among those which are capable of existing.

Q 4. For each of the following molecules, write the structure of an anion which is isostructural with it.

- (i) SO_2
- (ii) N_2O_4
- (iii) CS_2

Q 5. You know that the maximum value of the quantum number is equal to n-1 and that there are only two possibilities of electron spin and have also learnt how to write the electronic configuration of elements.

Imagine that the maximum value of the quantum number l could be equal to n and that there are three possibilities of electron spin instead of two that you know. Assume that all the other rules for quantum numbers and the method to write the electronic configuration of elements remain the same.

With the above imagination and assumption, write the electronic configuration of Ba.

(Hint: Atomic No. of Ba = 56)

Q 6. In the ground state caesium has atomic number 55.

(a) How many electrons have $l=0$ as one of their quantum numbers?

(b) How many electrons have $m_l = -2$ as one of their quantum numbers?

(c) How many electrons have $m_l = +1$ as one of their quantum numbers?

Q 7. A solution containing some cations of a group forming soluble sulphides gives yellow precipitate 'A' on addition of $K_2Cr_2O_4$ solution in the presence of acetic acid buffer at pH 4.74 ($K_{sp} = 8.5 \times 10^{-11}$). The precipitate is filtered off and the filtrate is treated with ammonia, and alcohol till a light yellow precipitate of 'B' is formed, ($K_{sp} = 3.6 \times 10^{-5}$). The precipitate is again separated and ammonium oxalate is added which results in the precipitation of a white substance 'C' which is filtered. The filtrate is treated with ammonia and Na_2HPO_4 which results in the precipitation of a white substance 'D'. The first member of the group which is not present in the above solution forms covalent halides soluble in organic solvents. Which hydrolyse in water. This particular member also forms metal carbide 'E' which yields methane on hydrolysis.

a) Identify A, B, C, D and E, write chemical reactions associated with their identification.

b) Estimate the extent of alterations of pH which is likely to take place when 0.1 mole NaOH is added to a litre of this buffer.

c) also predict the extent of change in pH on addition of same amount of base if the solution (0.5 M acetic acid) is not buffered.

d) Write a chemical equation which show hydrolysis of 'E'.

e) Write a reaction of the hydrolysis of calcium carbide

Q 8. A non-metal X burns in air to form a compound XO_2 which reacts with PCl_5 to form a fuming liquid.

$XOCl_2$, XO_2 is slowly oxidized to XO_3 at 670K temperature, according to the reaction

$2\ XO_2(g) + O_2(g) \longrightarrow 2XO_3(g)$; $\Delta H = -1.88kJ\ mol^{-1}$, $\Delta S = 248.5kJmol^{-1}$

The XO_3 is soluble in one of the oxo-acids of X. When XO_2 is passed through strong alkalies it dissolves to produce XO_3^{2-} which gets reduced to O_4^{2-} in the presence of Zn when 0.174 g of the sodium salt of $X_2O_4^{2-}$ are added to an excess of ammonaical silver nitrate solution 0.002 mole (0.2158 g) of Ag are precipitated.

a) Calculate the mass number of X.

b) Calculate free energy for the reaction of oxidation of XO_2 to XO_3 and predict the feasibility of the reaction.

c) Write the structural formula for any one axo-acids of X.

d) Calculate the oxidation number of X in one of its oxo-acids.

Q 9. Two gases 'A' and 'B' are allowed to interact to produce a gaseous compound of nitrogen through a series of experiments in which various mixtures produced are made to react. The temperature and pressure being maintained throughout.

	Initial mixture			
S.No.	**Vol. of 'A' (cm^3)**	**Vol. of 'B' (cm^3)**	**Volume of product (cm^3)**	**Total volume of gases after reaction (cm^3)**
1.	30	10	20	40
2.	10	15	20	25

3.	10	20	20	30
4.	40	20	40	60
5.	15	20	30	35
6.	25	30	50	55
7.	10	40	20	50

a) Calculate the oxidation number of the nitrogen in the product.

b) List various reactions to produce HNO_3 from the product formed above.

c) Write a reaction through which the acid can be prepared using ammonia.

d) Write a reaction showing the formation of nitronium ion from conc HNO_3.

Q 10. Dinitrogen tetraoxide (N_2O_4) breaks down into nitrogen dioxide (NO_2) when heated. The reaction is reversible. The equilibrium reaction between N_2O_4 and NO_2 can be represented by

$$N_2O_4 \rightleftharpoons 2NO_2$$

The temperature – volume curves for the gaseous mixtures are drawn (Fig.27).

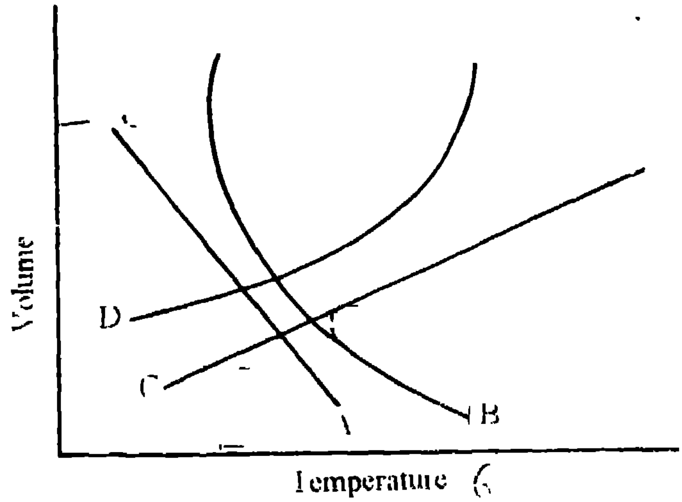


Fig.27

a) Which of the curves represent the change in volume of the gaseous mixture as a functions of temperature.

b) Liquid N_2O_4 is useful as a non-aqueous solvent.

(i) Write a reaction showing its self ionisation.

(ii) mark Bronsted acid-base on the dissociated species.

(iii) Write an equation showing the typical acid-base reaction.

(c) NO_2 is para-magnetic, N_2O_4 is not; explain.

Q 11. The curve below shows the 'I' ionization energies of the elements in the 'II' and 'III' periods of the periodic table. The alphabets on the horizontal line do not represent the actual symbols of the elements but just denote an element different from the other.

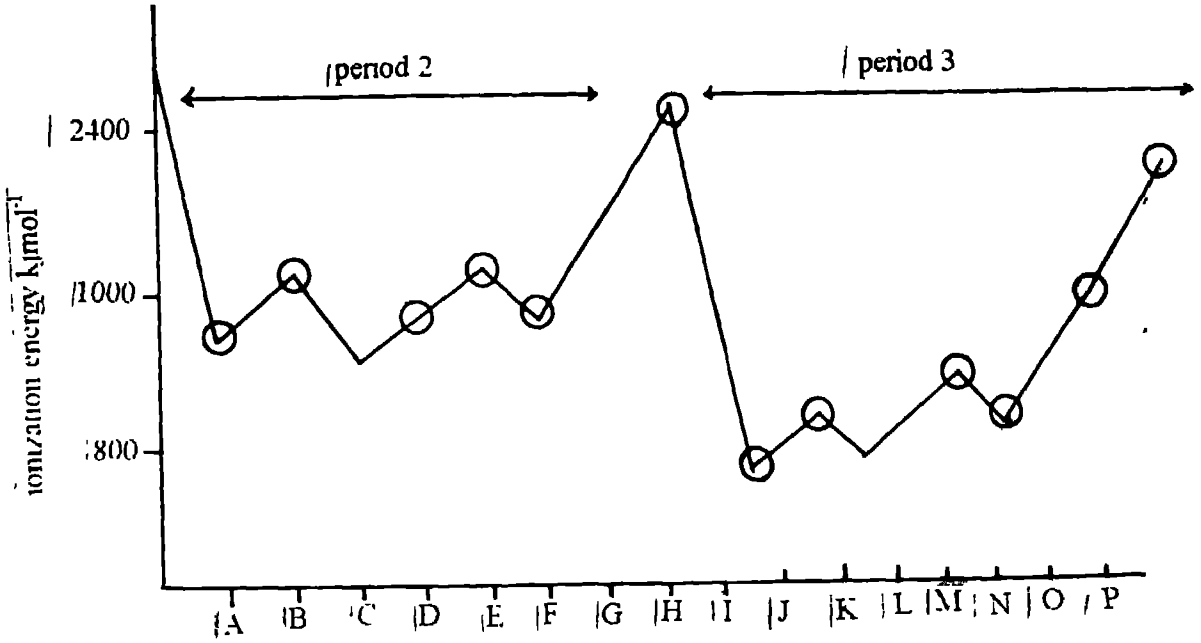


Fig.28

a) Write the alphabets which indicate inert gases.

b) Write the electronic configuration in boxes showing the spins indicated by 'B', and 'J'.

c) Which two elements are likely to form the most ionic compound.

d) Which alphabet indicate an element whose 'II' ionization energy will be drastically higher than the 'I' ionization energy.

Q.12. 'A' is reddish-violet crystalline solid having a slightly moist appearance. It is insoluble in water, organic solvents and in a solution of NaOH, but dissolves freely when warmed with conc HNO_3 forming an acid 'B' When heated with O_2 or Cl_2, 'A' burns forming dense white fumes which in each case, dissolves in water and forms acid.

a) Identify 'A' and 'B'.
b) Write down the structure of 'B'.
c) What will be basicity of 'B' ?
d) What happens when 'B' is heated ?
e) Explain the reaction of 'A' with concentrated HNO_3.

Q.13. A substance 'X' dissolved in hot conc HCl and on treating the solution with NaOH a white precipitate is formed which dissolves in excess of NaOH solution giving a solution with strongly reducing properties. On heating 'X' with sulphur a brown powder 'Y' was formed which dissolves in conc HCl. 'Y' dissolves on warming with yellow ammonium sulphide solution and on adding HCl, a yellow Precipitate was formed. When 'X' was strongly heated in air a white powder 'Z' was obtained which could be dissolved only in conc H_2SO_4. When 'Z' was fused with NaOH and extracted with hot water, white crystals were obtained.

a) Identify 'X', 'Y' and 'Z'.
b) Explain the chemical reactions involved in the said process.
c) 'Z' is an acidic, basic or Amphoteric and explain why ?

Q.14. 'Y' was prepared as a fine white precipitate by adding dil HCl to a solution of a solid 'X'. 'Y' was filtered washed and dried. On heating a mixture of 'Y' and potassium chlorate an explosion occurred. On warming 'Y' with conc HNO_3 brown fumes were given off and an acid 'Z' was left. 'Y' reacted slowly with a hot conc solution of NaOH to give 'X' and other products.

a) Identify 'X', 'Y' and 'Z'.
b) 'Z' is mono-basic or dibasic acid.
c) Explain why 'Z' has high boiling point ?

d) What are the uses of 'X'?

e) What are the allotropes of 'Y'?

f) Explain the chemical reactions involved in the said process.

Q 15 A molar solution of copper sulphate (solution 'A') and potassium sulphate (Solution 'B') were mixed in the proportions shown below. The mixed solution were then allowed to evaporate to dryness and the residue was examined.

(i) 10 mL of 'A' and 5 mL of 'B' gave a mixture of light blue and dark blue crystals.

(ii) 10 mL of 'A' and 10 mL of 'B' gave light blue crystals only.

(iii) 5 mL of 'A' and 10 ml of 'B' gave a mixture of light blue and colourless crystals

The light blue crystals were found to contain 24.4% water of crystalization.

(a) Suggest a formula for the light blue crystalline substance.

(b) What ions would you expect to be present in its aqueous solution.

(c) Give one test for the identification of each ion.

Q. 16 A colourless crystaline solid 'X', was dissolved in water. On addition of ammonium sulphide solution a white precipitate was formed. This precipitate was dissolved in the least possible amount of hydrochloric acid and the hydrogen sulphide was boiled off. When a solution of ammonia was added to the resulting solution, a white precipitate was formed which was soluble in excess of ammonia solution. On heating 'X' with conc H_2SO_4, a reddish acid gas was given off, part of which condensed to a dark brown liquid.

a) Identify 'X' and explain the reaction involved.

b) Describe and explain what happens when solutions of ammonium chloride and ammonia are together added to a solution of 'X'

Q 17 A metallic ore when heated with potassium carbonate in air (a complex

oxide which contains iron in addition to the element 'A') gives a yellow solid 'B' which is soluble in water. The iron is removed as an insoluble iron oxide Fe_3O_4. Using a 336 g sample of the ore, the dry weight of iron oxide obtained was 116 g. If 'B' is dissolved in water and the solution acidified, an orange solution of compound 'C' is obtained.

A solid sample of 'C' when treated with potassium chloride and conc H_2SO_4 gives a red brown liquid 'D'. When hydrogen peroxide is added to an acidified solution of 'C', a blue colour develops in the solution . This blue colour can be extracted into diethyl ether.

When 'C' is heated with ammonium chloride an oxide 'E' of the element A is formed. 'D' is immediately hydrolysed by water to produce hydrogen chloride and a solution from which 'B' can be isolated after the addition of potassium chloride

[Hint: H = 1.0; C = 12.0, N = 14.0; 0 = 16.0, Fe = 56.0; atomic weight of element A = 52.0]

a) Identify the element 'A' and the compounds B,C,D and E.

b) Write equations for the reactions involved in the conversions: $B \rightarrow C$, $C \rightarrow D$, $C \rightarrow E$ and $D \rightarrow B$.

c) What is the formula of the ore ?

Q. 18 When Iron (III) chloride is added to a hot aqueous solution of ammonium chloride and the solution is cooled, a solid 'X' separates. 'X' is completely decomposed by dil alkali.

a) Show that 'X' contains iron (III), ammonium and chloride ions.

b) Determine the percentage of iron in 'X'.

c) Find out whether 'X' is a double salt or a complex salt.

Q. 19 Explain the following:

a) Copper (I) chloride is insoluble in water and in dil HCl but dissolves in Conc HCl.

b) A dark blue precipitate is obtained on mixing aqueous solutions of copper (II) sulphate and sodium hydroxide. This precipitate darknes on heating.

c) On adding potassium cyanide to a solution containing copper (II) ions, the blue colour is considerably reduced and on passing hydrogen sulphide through this solution copper (II) sulphide is not precipitated.

d) The solubility of silver chloride in aqueous solutions of HCl at first decreases and then increases as the concentration of the acid is increased.

e) Silver chloride dissolves in ammonia solution whereas silver iodide does not.

Q. 20 A transition element is one which posses partially filled 'd' orbitals in its penultimate shell. This definition excludes zinc, cadmium and mercury from being the transition elements as they do not have a partially filled 'd' orbitals. However, they are also considered as transition elements because their properties are an extension of the properties of transition elements. Transition metals posses high melting and boiling points and high density. They are malleable and ductile and conduct heat and electricity.

Transition metal ions generally posses unpaired electrons and are coloured and paramagnetic.

They from complex ions and alloys with one another.

a) Why transition elements show some well defined, horizontal similarities in physical and chemical properties in contrast to s and p block elements.

b) Transition elements exhibit variable oxidation states in their compounds. However Sc and Y are exceptions, Why?

c) Transition metals are moderately electropositive to be noble in nature. Name two noble transition metal one each from 4d and 5d series.

d) How many unpaired electrons will be present in Mn^{2+}. What value of magnetic moment you will observe for it.

e) Why transition metal ions form more stable complexes as compared to the non-transition metal ions.

f) Transition elements form compounds with Lewis acid like Co, Ni etc. What is the oxidation state of Nickel in $Ni(CO)_4$

Q. 21 One of the most revealing features of the transition elements is that they exhibit a variety of oxidation states in their compounds. In contrast to this s-block elements show the group valency only and the p-block elements exhibit the group valency or a valency of two units less than the group valency. The maximum oxidation state of transition elements in oxyfluoro and chloro compounds corresponds to the total number of the ns and (n-1) d electons. The oxidation state in a series increases regularly. It reaches maximum value near the middle of each series and gradually decreases.

a) What is the co-ordination number of transition metal ions in oxidation state 'II' and 'III'.

b) Why for a given transition elements oxidation state differs by 2 as in the main group p-block elements.

c) In Cu and Cr one 's' electron moves into the 'd' orbital because of additional stability of exactly half filled and completely filled 'd' orbitals. Name the elements of 'II' and 'III' transition series in which also the 's' electrons move to the 'd' orbitals. Mention the forces whose net effect determines the electronic configuration of these elements.

d) What are the factors which determine the relative stabilities of the different oxidation states of transition elements.

e) Transition elements form compounds in lower oxidation states of 1,0, - 1 etc. but they are not very stable except those of Cu (I). Why copper (I) compounds are more stable?

f) Why higher oxidation states become more stable for the 4d and 5d series than the corresponding states of the 3d series?

Q 22 A white amorphous powder 'A' on heating yields a colourless gas 'B' and a solid 'C' The gas 'B' turns lime water milky but milkiness disappear with the continuous passage of gas.

Compound 'C' dissolves in dil acid gives a white precipitate on addition of $K_4Fe(CN)_6$ solution. The solution 'A' gives a white precipitate 'D' on addition of excess of NH_4OH and passing H_2S gas.

a) Identify 'A', 'B', 'C' and 'D'

b) Give chemical equations of various processes involved.

c) What happens when $K_4Fe(CN)_6$ solution is added in the solution of 'C' in dil acid.

Q.23 A transition metal forms hydrated ions $[M(H_2O)_6]^{2+}$ and $[M(H_2O)_6]^{3+}$ Two separate solutions, the first molar with respect to the M^{2+} (cations)and the second with respect to the M^{3+} (cations) are made up.

Which solution would you expect to be more acidic and why ?

Q. 24 The inner transition elements are those with underlying (n-2) incomplete f-orbitals, two series of such elements are known. The first of which is called lanthanides. It comprises of fourteen elements At No 58 to At No 71 following lanthanum and are called lanthanides or Lanthanones. The second series is known as the actinide series (5f). This series also comprises of fourteen elements, following actinium (At No 89) and consists of the elements from At No. 90 Thorium to At No 103 Lawrencium.

a) Why Lutetium (lu) and Lawrencium (Lr) do not belong to inner transition series?

b) More than hundred minerals of lanthanides are known but out of them only two are of commercial importance. Name them.

c) All the lanthanides irrespective of their electronic configuration exhibit an oxidation state of +3, Explain Why ?

d) Lanthanide ions have characteristic colours. Do you Think that their colour is influenced by the anions or by any complexing ligands.

Q. 25 The following are standard redox potential in volts in I M acid solution of the reactions

$M^{n+}/M^{(n-x)+}$

$M^{n+} + X\bar{e} \longrightarrow M(n-x) +$ (symbolised as Na^+/Na)

where, for example, the process

$Na^+ + \bar{e} \longrightarrow Na$ (symbolised Na^+/Na) is defind as having a large negative potential.

Cr^{2+}/cr	- 0.9V,
Cr^{3+}/cr^{2+}	- 0.4V,
Fe^{2+}/Fe	- 0.4V
Fe^{3+}/Fe^{2+}	- 0.8V
Mn^{2+}/Mn	- 1.2V
$Mn^{3+}Mn^{2+}$	+ 1.5V

use the above data to discuss:

a) The stability in acid solution of Fe^{3+} towards reducing agents as compared to that of either Cr^{3+} or Mn^{3+}.

b) The case with which metallic iron can be oxidised to Fe (II) ions compared to similar process for either metallic Cr or Metallic Mn

c) The result of treating a solution containing either Cr (II)) or Mn (II) with a solution containing Fe (III) ions.

Q. 26 Use the standard redox potentials given below to answer following

$Fe^{2+} + 2\bar{e} \longrightarrow Fe \; ; \quad E^o = -0.44V$

$Fe^{3+} + 2\bar{e} \longrightarrow Fe^{2+} ; \quad E^o = -0.76V$

$H^+ + \bar{e} \longrightarrow \frac{1}{2}H_2 \; ; \quad E^o = 0\,V$

$Ti^{2+} + 2\bar{e} \longrightarrow Ti \; ; \quad E^o = -1.63V$

$Ti^{3+} + \bar{e} \longrightarrow Ti^{2+} ; \quad E^o = -0.37V$

$\frac{1}{2}O_2 + 2H^+ + 2\bar{e} \longrightarrow H_2O ; \quad E^o = 1.23V$

What result would you predict for the action of dil HCl and Ti (II) ions, both in complete absence of air ? Explain is detail.

Q 27 The fourteen elements following actinium (Ac) (atomic No. 89), from the atomic No. 90 (Th) to atomic No. 103 (Lr) are called actinides. They result from filling of the 5f orbitals and are analogous to the lanthanides.

a) Name the naturally occurring actinides.

b) Lanthanides do not from oxocations whereas actinides do, why ?

c) What is the oxidation state of actinides ?

d) What is the main source of uranium ?

e) Write the Electronic configuration of protactinium.

f) Why most of actinides are radioactive ?

Q. 28 When a solid 'A' was fused with a mixture of KOH and $KClO_3$ a green compound 'B' is formed. On heating this compound with CO_2, it gave a dark coloured solution 'C'. 'C' on warming with $H_2C_2O_4+H_2SO_4$ gave a colourless solution 'D'.

a) Identify 'A', 'B', 'C', and 'D'.

b) Calculate the Oxidation states of M in all the compounds.

c) Will compound 'C' be oxidising or reducing agent ?

d) Explain all the chemical reaction involved.

Q. 29 A pink coloured aqueous solution of cobalt (II) salt 'A' after aeration and addition of aqueous ammonia solution gives an orange yellow complex 'B' which upon substitution of one amine ligand by water gives another pink coloured complex 'C'. Complex 'C' upon dehydration gives violet coloured complex 'D', which upon deammination (one mole) gives complexes 'E' and 'F' with violet and green colour.

a) Write down the formulae of each compound 'A', 'B', 'C', 'D', 'E' and 'F'

b) Write down the number of counter anions.

c) Give possible isomerism in each case.

d) Give IUPAC name of each compound.

Q. 30 A complex $[Co(L)_4x_2]^+$ containing L as monodentate ligand was replaced by bidentate ligand (L-L) giving complex $[Co(L\text{-}L)_2x_2]^+$

a) Mention the isomerism which are possible in both type of the complexes.

A complex of general formulae $[M(L)_4x_2]x'_2$ (x and x' are different

halogens) in water gives creamy precipitate with Ag^+ .

b) Write down the anions which gives creamy precipitate with Ag^+ .

c) Under what condition, Ag^+would give white precipitate write down the formulae of the complex.

d) Write down the IUPAC name of the complexes in both conditions

Q.31 A metallic hailed MX_2 (A) reacts with Grignard reagent and produces magnesium chloride/magnesium bromide alongwith an organometallic compound 'B'. The metallic halide 'A' reacts with aromatic hydrocarbon and its organic derivatives are also used in the preparation of many other organometallic compounds besides it is added to double bond of ethylene forming compound 'C' and catalyses the hydration of acetylene forming an aldehyde 'D'.

a) Identify the above compounds 'A', 'B', 'C', and 'D'.

b) Write down the equations involved in each step.

Q.32 EDTA containing Lanthanides do not precipitate with oxalate ions. However in presence of acid, some of the lanthanides are immediately precipitated.

a) Name the lanthanide ions precipitated as mentioned above and write down the general formulae of the complex thus formed.

b) Write the IUPAC name of the complex in general.

c) Which lanthanide ion is separated very fast and under what conditions ?

Q. 33 Lathanides comrise of the elements with (n-2) in complete f orbitals.

a) Explain how Lanthanides are used as biological tracer and as a wavelength calibrator of instruments?

b) Lanthanides form only a few organometallic compounds especially with ligands like CN^- and CO but same is not true with transition metals, why ?

c) Give four conditions for the occurrence of 2+ and 4+ oxidation

states of Lanthanides.

Q. 34 By the use of valence bond theory, the geometry of the complexes are predicted qualitatively.
Why Ag^+ is larger in square planar environment than it is in tetrahedral one. However, this is not the case in Ni^{2+}.

Q. 35 A compound with empirical composition $CrCl\ SO_4 . 5H_2O$ is found in two isomeric form 'A' and 'B'. Forms 'A' gives white precipitate with $BaCl_2$ whereas form B gives white precipitate with $AgNO_3$.

a) Name the counter anions in both complexes and write down the equations involved in both the reactions with $BaCl_2$ and $AgNO_3$.
b) Write down the IUPAC name of both the complexes.
c) Name the isomerism involved in 'A' and 'B'.
d) Will the complexes be inner orbital or outer orbital ? Explain.

Q. 36 Nickel and platinum belong to same group in the periodic table and both form complexes of the type $(MCl_4)^{2-}$, $M = Ni^{2+}$ and Pt^{2+} but these complexes show different properties.

a) Why the geometry of both complexes are different ?
b) Why the magnetic moment are different ?
c) What are the IUPAC names of these complexes ?

Q. 37 A complex $[Co(NH_3)_5Cl]^{2+}$ was treated with $NaNO_2$ in presence of dil HCl, an unstable yellow complex 'x' is formed. Whereas on keeping this in acid or by using conc HCl in place of dil HCl, a stable red complex 'Y' is formed

a) Write down the formula of yellow compound and name of 'X'.
b) Write down the formula of Red compound and name of 'Y'.
c) Name the isomerism involved in these complexes.
d) What is ambidentate ligand and Give examples of such ligands ?

Q. 38 Coordination compounds show various characteristic properties like colours, magnetic moment etc. Using the valence bond theory explain :

a) The geometry of the following complexes

(i) $[CuCl_2]^-$, (ii) $[MnBr_4]^{2-}$, (iii) $[Zn\ (CN)_4]^{2-}$ and (iv) $[Ag\ (CN)_2]^-$

b) Among the following compounds which one shows the lowest degree of paramagnetism at 298 K.

(i) $FeSO_4$, $6H_2O$ (ii) $NiSO_4\ 6H_2O$ (iii) $CuSO_4\ 5H_2O$

c) Identify the coloured complexes from the following :

(i) $K_3\ [VF_6]$, (ii) $Ti\ [NO_3]_4$, (iii) $[Cu\ (NC\ CH_3)_4]^+$, BF_4^-

(iv) $K\ [Ag\ (CN)_2]$

d) Why do octahedral complexes of Ni^{2+} always have high spins ?

Q. 39

a) A radio-isotope decays at such a rate that after 69 minutes only quarter of the the original substance remains. Calculate the disintegration constant and half-life of the radio-isotope

b) The half-life of a radio active element is 27.96 days. Calculate the time taken by a given sample of the element to reduce to 1/8th of its initial activity

c) Half-life period of a radioactive element is 1.39×10^{10} years, each atom of which disintegrates with the emission of a single α - particle. Calculate the number of α - particles emitted per second from one gram of the substance. Atomic mass of element is 232.

d) At radioactive equilibrium, the ratio between the atoms of two radioactive elements 'A' and 'B' was found to be $3.1 \times 10^9 : 1$. If the half-life period of the element 'A' is 2.10^{10} years find out the half-life period of 'B', as well as its rate of disintegration.

e) 1 g of radium is known to emit 3.70×10^{10} particle/sec. Calculate the half-life period of radium (at wt. Ra=226)

Q. 40 a) How many protons and neutrons are there in the following

$${}_1H^1, {}_8O^{18}, {}_{90}Th^{234}, {}_{92}U^{238} \text{ and } {}_{88}Ra^{226}$$

b) How many α-β particles are lost when ${}_{92}U^{238}$ is converted to ${}_{88}Ra^{236}$

c) Depict the following nuclear reactions with suitable equations.

(i) ${}_{11}Na^{22}(p,n)$; (ii) ${}_{17}Cl^{37}(p,n)$; (iii) ${}_{26}Fe^{58}(D,p)$, (iv) ${}_{10}Md^{255}(\alpha, n)$

d) Complete the following nuclear reactions

(i) ${}_{92}U^{238} \longrightarrow {}_{90}Th^{234} + \ldots\ldots$ (ii) ${}_{13}Al^{27} + {}_2He^4 \rightarrow {}_{15}P^{30} + \ldots\ldots\ldots$

e) Uranium 238 (atomic No 92) during various disintegration loses 8 α -paricles and 6 β-particles.

(i) What will be the At No. and At. Wt. of the new product ?

(ii) To which group of periodic table will it (new product) belong if ${}_{92}U^{238}$ belongs to the group-VI ?

Q. 41

The half-life period of ${}_{92}U^{238}$ and ${}_{92}U^{235}$ are 4.5×10^9 yrs and 7.1×10^8 yrs respectively. The relative abundance of these two isotopes at present are found to be 99.2% and 0.8% respectively. Calculate the age of the earth.

Q. 42

The nucleidic ratio ${}_1H^3$ to, ${}_1H^1$ in a sample of water is 8.0×10^{-18}, tritium undergoes decay with a half-life period of 12.3 years. How many tritium atom would 10 0 g of such a sample contain after 40 years the original sample was collected ?

Q. 43

In nature a decay chain series starts with ${}_{90}Th^{232}$ and finally terminates at ${}_{82}Pb^{208}$ A thorium ore sample was found to contain 8×10^{-5} mL of helium at STP and 5×10^{-7} g of ${}_{90}Th^{232}$. Find out the age of the ore sample assuming the source of the 'He' to be only due to the decay of ${}_{90}Th^{232}$.

Also assume complete retention of helium within the ore (Half-life of $_{90}TH^{232}$
= 1.39×10^{10} years)

Q.44

An experiment requires minimum beta activity produced at the rate of 346 beta particles per minute. The half-life period of $_{42}Mo^{90}$, which is a beta emitter is 66.6 hours. Find out the minimum amount of $_{42}Mo^{90}$ required to carry out experiment in 6.909 hours.

Q. 45

By plotting the binding energy per nucleon versus mass number, the curve is obtained as shown below:

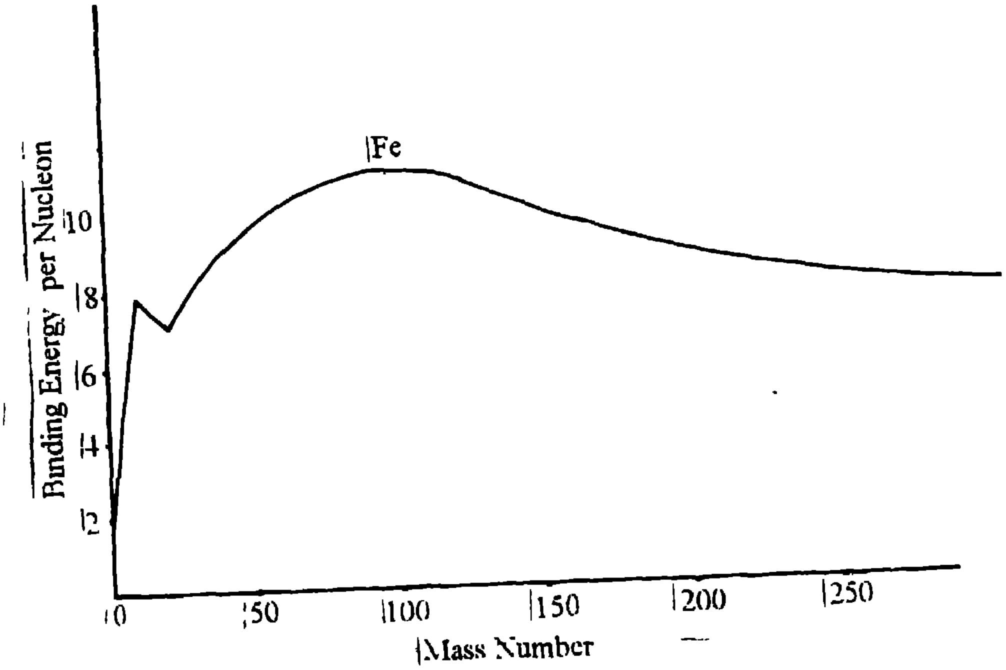


Fig. 29

a) What is binding energy ?

b) Which element under goes fission reaction ?

c) Which element undergoes fusion reaction ?

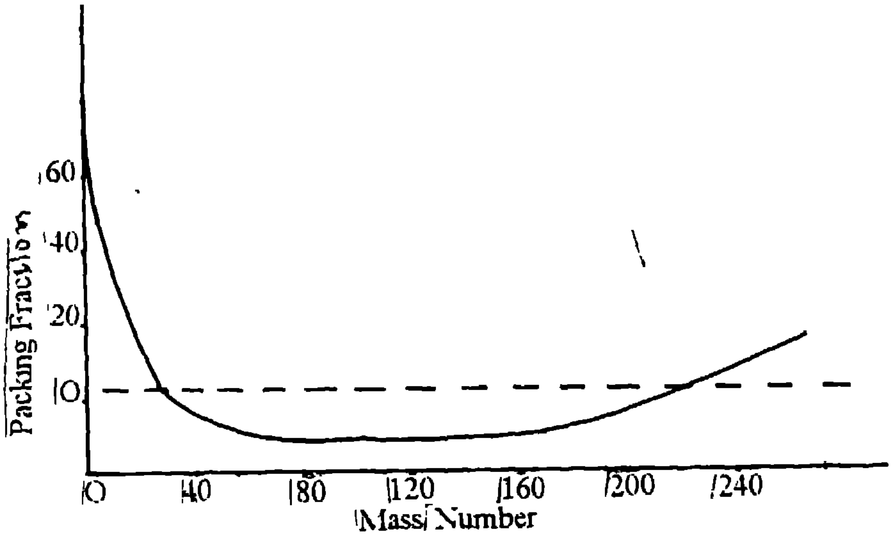
d) Which element is more stable ?

e) Why is the abundence of iron in earth crust is maximum ?

f) One of the stablest nuclei is $_{25}Mn^{55}$ it's atomic mass is 54.988 amu. Determine its total binding energy per nucleon. Given the mass of hydrogen atom is 1 00783 amu and mass of neutron is 1.00867 amu.

Q. 46

Study the graph between packing fraction vs mass No.



(Fig.30)

a) What is packing fraction ?

b) Why the element mass No 4,12 and 16 do not fall on the packing fraction curve ?

c) Lighter element upto mass No 20 has positive value of packing fraction, will they show nuclear fusion or Fission ?

d) Elements with mass No's20-180 have negative packing fraction and beyond 180 have positive packing fraction, will they show nuclear fission or Fusion ?

Q. 47 A small sample of gold was irridated in a nuclear reactor and the activity of the radioactive gold produced was measured with Geiger counter at various intervals of time.

The results are as follows.

Time in (h)	**Radioactive disintegration (counts per min)**
0.00	299
0.1	-
0.2	-
0.5	-
1.0	-
2.0	-
5.0	285
10.0	271
24.0	232
48.0	181
72.0	139
96.0	108

a) What are radioactive isotopes ? Give an example of its use in modern scientific practice.

b) Plot a graph with the data given above.

c) From the graph determine the half-life-period of radioactive gold.

d) Discuss the decay of radioactive gold with the help of the graph.

Q. 48 The thermal fission of uranium in a nuclear reactor produces radioactive isotopes of the rare gases Kr and Xe. The λ-activity of a mixture of Kr^{88} and Xe^{138} was measured at various times. In an identical situation the rare gases sample was passed over active charcoal to remove the Xe^{138} and the activity of the Krypton (Kr^{88}) alone was measured at various intervals of time as given below:

Time (min)	Decay of Kr^{88} and Xe^{138} Disintegration (counts/sec)	Time (min)	Decay of Kr^{88} alone Disintegration (counts/sec)
0	200	30	88
10	161	60	78
20	135	90	69
50	94	120	61
100	68	–	–

a) Find out the half-life and the decay constant (λ) for Kr^{88}.
b) What is the initial disintegration rate of the sample of Kr^{88}.
c) Determine the half-life of Xe^{138}.

Q. 49 If the nuclear fission reaction is made to occur at a controlled rate, the energy released can be harnessed for constructive rather than destructive purposes. The equipment used to carry out the fission reaction in a controlled manner is called nuclear reactor.

a) Write the name of the fissionable material used in nuclear reactor.
b) Write the name of the moderator which is used in nuclear reactor.
c) Give the name of the elements by which controlled rods are made up and what is its role?
d) What is the name of the isotope which is used to breed the fissionable isotope.
e) What is the use of the energy released during nuclear fission?

Q. 50 The phenomenon of Radroactivity was discovered by Henery Becqueral in 1896 in uranium. Such radioactive elements emit innumerable radiations which are composed of positively charged α-rays, negatively charged β-rays and electrically neutral γ rays. The activity of a radioactive element has been defined by a term half-life period which is the time during which half the total number of atoms of the radioactive element disintegrate.

a) Name an inert gas, a halogen and an alkali metal which is naturally occurring radioactive elements.

b) Why α-ray have more power of ionising gases than β-rays ?

c) Though the Kinetic energy of β-particles is less than α-particles, yet its effect on photographic plate is higher why ?

d) Half life periods of following elements are given as :

Elements	Half-life period
$_{86}Rn^{222}$	3182 s
$_{91}Pa^{234}$	1.18 min
$_{83}Bi^{209}$	5 days
$_{84}Po^{210}$	38 days
$_{90}Th^{234}$	21.1 days

Arrange these elements in order of their activity.

APPENDIX-I

ANSWERS

Class XI (Physical)

Q. 1.	a)	103.36 cm
	b)	103.36 g/cm^2
	c)	(ii) 74.46 cm
Q. 3.	a)	(i) 3.75×10^3 dm^3
		(ii) 307.2 K or 34°C
		(iii) 3.858×10^3 dm^3
	b)	200 torr
	c)	228 torr
	d)	(i) 4.5×10^{-5} gL^{-1}
		(ii) 4.3 gL^{-1}
		(iii) 95,555 times
Q. 4.	b)	3.019×10^{-3} L^{2}atm moL^{-1} K^{-2}
	d)	6.2L
	e)	0.966 atm, temperature = 15°C
Q.5.	a)	3.725×10^5 g
	b)	280.18 atm
Q.6.	a)	895.3 mmHg
	b)	0.0382 mol
Q. 7.	a)	655.6 torr
	b)	Ar = 25.97%
		CO_2 = 74.03%
Q. 8.	b)	For Hydrogen : 10016 K
		Oxygen : 1,60,256 K
	c)	(i) 3739.5 J mol^{-1}
		(ii) 6.0×10^{23} molecules/mol
Q. 14.	c)	6.791×10^{-3} min^{-1}

Q. 15.	d)	Average specific rate constant
		= 0.3253 h^{-1}
Q. 16.	e)	1.37 L
Q. 22.	c)	+ 414 $kJmol^{-1}$
Q. 23.	b)	(i) First experiment, First order, $k = 1.9 \times 10^{-4}\ s^{-1}$
		Second experiment
		First order, $k = 3.1 \times 10^{-4}\ s^{-1}$
		(iii) $k^1 = 1.9 \times 10^{-6}\ s^{-1}\ torr^{-1}$
Q. 28.	b)	Step - II : 0.01M
		Step - III : 0.002M
Q. 29.	b)	Expt. - 1 : 1.8259×10^{-2}
		Expt. - 2 : 1.8350×10^{-2}
	f)	Expt. - 1 : 1.8403×10^{-2}
		Expt. - 2 : 1.8583×10^{-2}
Q. 31.	c)	$9.215 \times 10^{-6}\ molL^{-1}$
Q. 33.	c)	$5.91 \times 10^{-4}\ molL^{-1}$
Q. 34	a)	12.8 g
	d)	9.81×10^{-2}atm
Q. 42.	a)	+ 0.1357 V
	b)	+ 0.174 V
1. 43.	e)	+ 0.7895V (oxidation half-cell)
		+ 0 2810 V (Reduction half-cell)
	f)	+ 1.10 V
Q. 47.	e.m.f. = 0.799 V	
	minimum voltage = + 0.337 V	
	c)	E_{ox} = + 0.059 V
		E_{red} = + 0.3075 V
Q. 48.	c)	e.m.f. of the first cell = +1.554 V
		e.m.f. of the second cell = + 0.54 V

Q. 49.	c)	-3984kJ
	d)	-3989kJ
Q. 51.	b)	1.29×10^5 kJ
	c)	902 g
	d)	64.86 L
Q.52.	c)	1.2 kgh^{-1}
	d)	618 gh^{-1}
Q. 53.	a)	243$kJmol^{-1}$
	b)	82.7$kJmol^{-1}$
Q. 55.	b)	785$kJmol^{-1}$
Q. 57.		1.63 kg

Class XI (Organic)

Q.7.	a)	19 g
	b)	38 g
Q. 8.		Starch
	a)	(i) 16 kJ
		(ii) 18 kJ
		(iii) 20 kJ
		Cellulose
		(i) 30 kJ
		(ii) 33 kJ
		(iii) 43 kJ
Q. 34.	a)	$C_2H_6O_6$
Q. 35.	a)	$CHCl_3$
Q. 38.	a)	Empirical formula : C_3H_3 Molecular formula : C_4H_6
Q. 47.	a)	$C_3H_8O_3$

Q. 48.	a)	C_3H_4
	b)	C_3H_4
Q. 49.	a)	Empirical formula : CH_2 Molecular formula : C_6H_{12}

Class XI (Inorganic)

Q. 7.		10.56 gL^{-1}
Q. 12.	a)	15.3 M
Q. 13.	a)	82.5%
Q. 14	a)	37.5%
Q.16.	a)	12.1N
	b)	$CaCO_3$ = 54.35% $MgCO_3$ = 45.65%
	c)	Iron
Q. 20.	g)	12.7g
Q. 27.	c)	2xmL
	d)	(Y-2x)mL
	e)	YmL
Q. 28.	b)	$G_r^Q = + 73.9\ JKmol^{-1}$
	c)	512 9 K
	e)	$\Delta G_r^Q = - 99.6\ JKmol^{-1}$
Q. 39.	b)	32.8%
Q. 46.	f)	805.4 g
Q. 47.	b)	1.62 g
Q. 49.	b)	960 kg

Class XII (Physical)

Q. 1. a) 59 56, 33.13, 3.96, 8.25, 1.30, 1.27, 3.61

b) 11.109 g

c) 100.591°C

d) 2.6739 g

e) 1.3210 mol L^{-1}

Q. 2. a) 0.0826 atm.

b) (i) 0.804, 0.196

(ii) 77.66%

(iii) 44.59 mol kg^{-1}

(iv) 3.125 mol kg^{-1}

c) 0.1057 atm.

Q. 3. b) 3 23, 3.759, 5.0274, 6.2149, 12.1486

c) 1.86°C kg mol^{-1}

d) H fusion = 6.003 kJ mol^{-1}

Q. 5. a) 0.1M

b) 0.099 mol kg^{1}

c) -0.184°C

Q. 6. e) 532.9 g mol^{-1}

Q. 7. d) 102g

Q. 8. e) 10 16 atm.

f) 0.41 mol L^{-1}

Q. 9. a) molarity = 18.3 mol L^{-1}

molarity = 500 mol kg^{-1}

b) 683 mL

c) 0.775 (apparent degree of dissociation

Q. 10. d) (iii) pressure required is more than 50 atm.

Q. 12. b) -1359 kJ mol^{-1}

Q. 13. b) First case : 670.8K

Second case : 900 K

Q. 14. First case ·

W_{rev} = -5227.2 J mol^{-1}

ΔG = -5227. J mol^{-1}

ΔS = 19.15 $JK^{-1}mol^{-1}$

Second case :

Wirrev = 0

ΔH = 0

ΔG = 0

ΔS = 0

Q. 15. Bond energy

C–H = 305.5 kJ

C ≡ H = 1028 kJ

Heat of combustion (acetylene) = -701.2 k J mol^{-1}

Q. 17. (i) - 240.59 kJ mol^{-1}

(ii) -3302.74 kJ mol^{-1}

(iii) -1298.36 kJ mol^{-1}

(iv) -874.87 kJ mol^{-1}

Q. 18. V_1 = 0.0582 dm^3

V_2 = 87.70 dm^3

W = 64.182 kJ mol^{-1}

Q = 0 985 kJ

ΔE = 7.784 kJ

ΔS = 160.38 JK^{-1}

Q. 19. (i) 1.55 kJ

(ii) 3.10 kJ

(iii) 0

(iv) 1.55 kJ

Q. 20. a) $\Delta G^{o}_{f\,cyclop}$ = -53.34 kJ mol^{-1}

$\Delta G^{o}_{f\,p}$ = -164.72 kJ mol^{-1}

$\Delta G^{o}_{f\,process}$ = 111.38 kJ mol^{-1}

b) ΔG^{o} = 1.45 kJ

Q. 21.	$\Delta H^{\circ}_{f\,C_2H_2(g)}$ = 227 kJ mol^{-1}
Q. 24.	$S^{\circ}_{298.15K,\,1bar}$ = 192 17 JK^{-1}
Q. 25.	a) 675 k J mol^{-1}
Q. 26.	ΔS = 109.82 JK^{-1} mol^{-1}
Q. 27.	a) 0.95 JK^{-1} mol^{-1}
Q. 28.	K_{eq} = 6.05
Q. 29.	a) - 64.84 kJ mol^{-1}
	c) 0.336 V
Q. 30.	b) 237.16 kJ mol^{-1}
Q. 31.	a) 0.008253 S m^{2}mol^{-1}
	b) 0.038224 S m^{2}mol^{-1}
	c) 0.37%^{5}
	d) 1.369 X 10^{-5}
Q. 32	b) 0.02957 V
Q. 34.	b) (ii) pH = 4.68
Q 35.	a) $\frac{dx}{dt} = k\,[A]\,[B]^2$
	b) k = 0.1 mol^{-2} L^2 min^{-1}
Q. 36.	decomposition = 67.17%
Q. 38.	(i) L mol^{-1} s^{-1}
	(ii) L mol^{-1} s^{-1}
	(iii) L^3 mol^{-3} s^{-1}
Q. 39.	k = 0.01 s^{-1}
Q. 42.	Temp = 311.34 K
Q. 43.	0.7488 atm.
Q. 45.	a) 154.45 pm
	b) 109.471°
Q. 46.	d) (i) 10^{-7}s
	(ii) 108.8 K

Q. 48.	a)	atm^{-1}
Q. 50.		$4.3\ m^2$

Class XII (Organic)

Q. 7	a)	$C_4H_9NH_2$
Q. 26.	b)	-27,000 cal
Q. 31.	(b)	$-3.7\ kJmol^{-1}$
Q. 32.	a) (i)	$-3.3\ kJmol^{-1}$
	(ii)	$27.2\ kJmol^{-1}$
	(iii)	$30.6\ kJmol^{-1}$
	(iv)	$10.5\ kJmol^{-1}$
	d)	$-76\ 6\ kJmol^{-1}$
	e)	$-89.2\ kJmol^{-1}$
	f)	$-\ 49.4\ kJmol^{-1}$

Class XII (Inorganic)

Q. 7	b)	pH variation 0.02
	c)	pH variation 12
Q. 8.	a)	32
	b)	$\Delta G = -\ 166496.88\ kJmol^{-1}$
	d)	+6
Q. 9.	a)	+4
Q. 39.	a)	$k = 0.0201\ min^{-1}$ half life = 34.47 min
	b)	83.91 days
	c)	4102 disintegration s^{-1}
	d)	half life period of B = 6.45 y Rate of disintegration = $0.1074\ y^{-1}$

e) half life = 1582.32 y

Q. 41. 5.865×10^{9} y

Q. 42 5.624×10^{7} atoms

Q. 43. Age of the sample = 4.89×10^{9} y

Q. 44. 3.451×10^{-18} mol

Q. 45. f) 8.765 MeV

Q. 47 c) ~ 65 h

Q. 48. a) Half-life = 170 min

decay constant = 4.076×10^{-3} min

b) 100 counts s^{-1}

c) Half life = 17 min

APPENDIX - II

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